40 By 30

A 40% Renewable Heat Vision by 2030 Delivering 7% CO_2 Abatement per Year

April 2021

Report prepared by
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Sustainable Energy Engineers

Renewable Energy Ireland

Table of Contents

List of Abbreviations and Acronyms

BioLPG: Biopropane (propane produced from renewable feedstocks)

BER: Building Energy Rating

Cre: Composting & AD Association of Ireland

CRU: Commission for Regulation of Utilities

CHP: Combined Heat and Power

DAFM: Department of Agriculture, Food and the Marine

DECC: Department of Environment, Climate and Communications

DHLGH: Department of Housing, Local Government and Heritage

DHW: Domestic Hot Water

DoF: Department of Finance

DPER: Department of Public Expenditure and Reform

EPA: Environmental Protection Agency

EGD: European Green Deal

ETS: Emissions Trading System

FEC: Final Energy Consumption

GAI: Geothermal Association of Ireland

GHG: Greenhouse Gas (emissions)

GSI: Geological Survey Ireland

GW: Gigawatt (1,000,000 kW)

GSHP: Ground Sourced Heat Pump

GWh: Gigawatt hour (1,000,000 kWh)

HLI: Heat Loss Indicator

HPA: Heat Pump Association of Ireland

IrBEA: Irish Bioenergy Association

IrDEA: Irish District Energy Association

ktoe: kilo tonne of oil equivalent (equal to 11.63 GWh)

kW: kilowatt (1,000 W)

kWh: kilowatt hour (1,000 Wh)

LGI: Liquid Gas Ireland

LCOE: Levelised Cost of Energy

Mt: Million tonne (of CO_2)

MW: Megawatt (1,000 kW)

MWh: Megawatt hour (1,000 kWh)

NECP: National Energy and Climate Plan

NECP_WAM: National Energy and Climate Plan, With Additional Measures scenario

NORA: National Oil Reserve Agency

OGP: Office for Government Procurement

NUIG: National University of Ireland Galway

PCRW: Post-Consumer Recovered Wood

PES: Primary Energy Supply

REI: Renewable Energy Ireland

RED II: Renewable Energy Directive II

RES-Gas: Gaseous fuels from renewable sources, incl. biomethane, BioLPG, hydrogen from renewable energy sources.

RES-H: Renewable heat, heat from renewable energy sources

RGFI: Renewable Gas Forum Ireland

SEAI: Sustainable Energy Authority of Ireland

SSRH: Support Scheme for Renewable Heat

SDG's: Sustainable Development Goals

TW: Terawatt (1 billion kW)

TWh: Terawatt hour (1 billion kWh)

W: Watt

Wh: Watthour

yr: year

Acknowledgements

Renewable Energy Ireland

This report is the result of a study commissioned by Renewable Energy Ireland (REI). REI was established in January 2019 as an open partnership of sustainable energy associations working collectively to support the energy transition in Ireland. The shared vision is that by 2050 Ireland will be energy independent through using indigenous, clean, carbon-free renewable energy supported by, and supporting, communities across our country. The organisation brings together organisations working in wind, solar, marine and bioenergy. REI would like to thank Marie Donnelly (former REI Chairperson) and Dr. Tanya Harrington (current REI chairperson) and the steering committee members for their contribution to the development of this study. REI would like to also acknowledge the work of XD Consulting in compiling this report. The Irish Bioenergy Association on behalf of REI completed an administrative role for the development of this report. Further details of the work of REI can be found at: https://renewableenergyireland.ie/

XD Consulting
Sustainable Energy Engineers

XD Consulting is an integrated sustainability consultancy providing multi-disciplinary advice and support in the area of renewable energy and energy efficiency. It was created by Xavier Dubuisson Eng. MSc. in 2007 on the basis of his now 25-year experience as a sustainable energy engineer having worked with leading organisations in this field in Ireland, Belgium and other European countries. Xavier would like to acknowledge the contribution of Shay Kavanagh and Siddharth Joshi to this study, and give thanks to Renewable Energy Ireland and its steering committee for their commitment and support during the project.

Sponsors of the Plan

Renewable Energy Ireland

irbea irish bioenergy association

IRDEA Irish District Energy Association

Renewable Gas Forum Ireland

Executive Summary

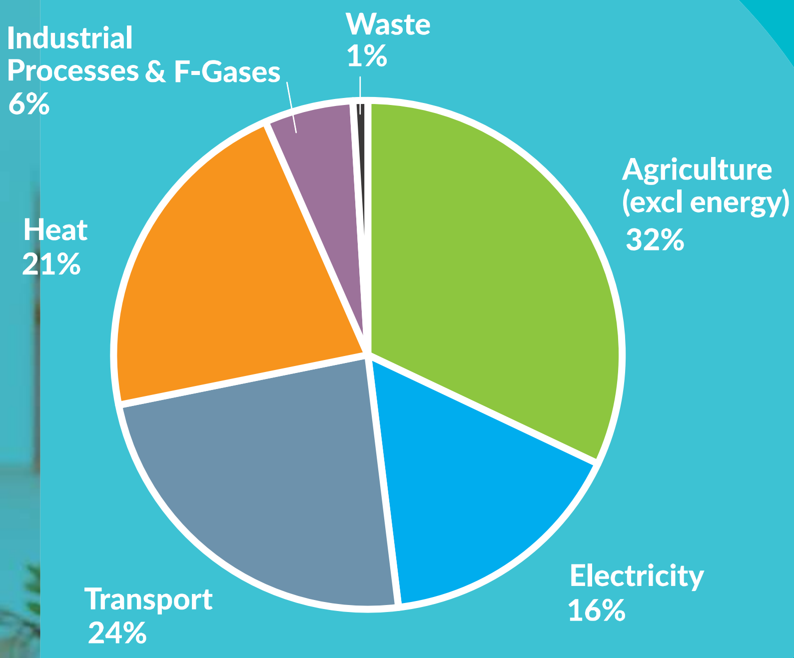
Executive summary

Heat is fundamental to our well-being, warming our homes, offices and workplaces, and is an essential ingredient in many industrial processes. But it is also a big part of Ireland's climate action challenge.

Proposed renewable heat technologies address the EU's core principles of sustainability, security of supply and competitiveness.

Thermal energy use accounted for **40%** (41 TWh/yr) of all energy use and circa **20%** of all **greenhouse gas emissions** in 2018 (almost 14 million tonnes of CO_2).

€3 billion was spent on **heating** that same year and Ireland depends on **fossil fuel imports** for about **65%** of its **thermal energy** use, a key factor in the country's vulnerability in terms of energy security.



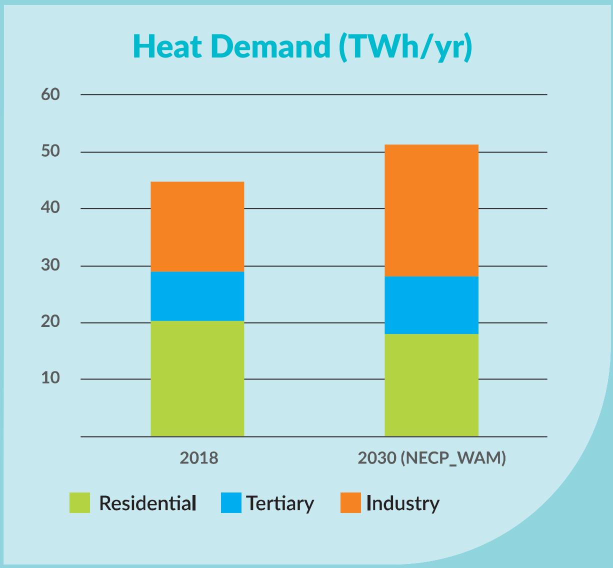
Breakdown of greenhouse gas emissions in 2018

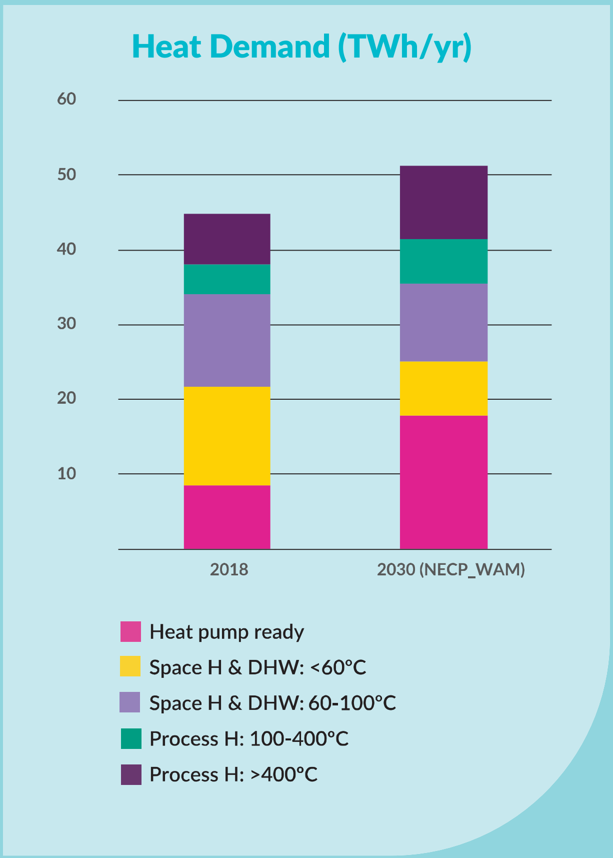
Renewable heating can deliver the 7% CO_2 abatement per year target

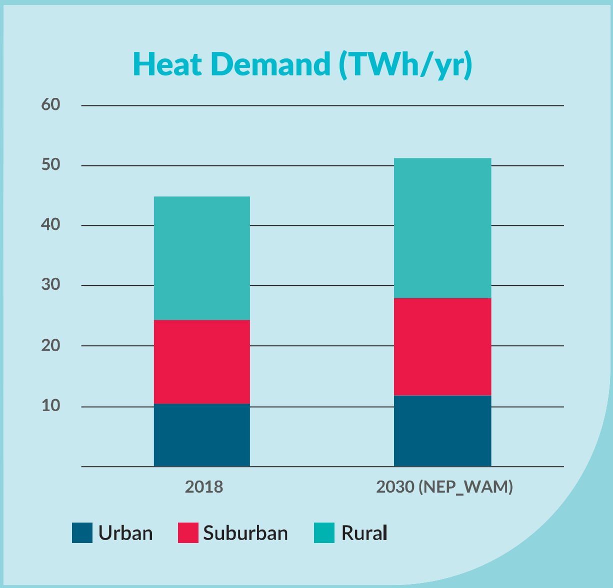
The Programme for Government includes a target of 7% annual reductions in CO_2 emissions over the next decade which equates to a 51% reduction in ten years, meaning Ireland must transition rapidly to renewable heat. Renewable Energy Ireland commissioned this report to set out an ambitious and feasible target for reducing our emissions in the heat sector by 2030. A number of scenarios are modelled in this study, including a 'RES-H_7%' scenario, which demonstrates that a 40% renewable heat share in 2030 compared to 6% today will halve the carbon emissions associated with heating in Ireland, going from almost 14 $MtCO_2$ today to almost 7 $MtCO_2$ by 2030. Therefore, aiming for 40% renewable heat by 2030 will put the heating sector on track to deliver the government's 7% per year CO_2 reduction target. The report describes how this ambitious target of 40% renewable heat for 2030 is both practical and realistic, displacing imported fossil fuels with renewable and sustainable energy resources, so it will not only tackle climate change but also provide a strong economic stimulus to the economy, particularly in rural areas in Ireland.

Understanding how we use our heat is vital to identifying appropriate low-carbon solutions

The starting point for the analysis was to profile the national heating requirement and project how it will evolve towards 2030. Over two-thirds of the national heat demand is in buildings where improvements in buildings' efficiency will facilitate the deployment of low-temperature systems such as heat pumps. The substantial share of high heat density areas provides strong opportunities for district heating networks to play a much bigger role in servicing towns and cities cost-effectively with surplus heat from industry, data centres, waste-to-energy plants, and others. Bioenergy solutions using wood fuels, biogas/biomethane and BioLPG will play a key role in decarbonising hard to retrofit buildings and industrial processes requiring high temperatures. The remaining third of the national heat demand is in industry. Focus on the industrial sector is all the more important in that economic growth is projected to drive up the national heat demand by 14%.







A 7% CO_2 reduction per year

will boost Ireland's economy and improve energy security

The cost of each scenario in this study is modelled in detail by including all costs for upfront investments, operation and maintenance, fuel and carbon emissions. The results indicate that achieving the 40% renewable heat share and delivering the 7% CO_2 reduction per year required, is only 10% more costly than continuing with current policy, which will deliver just over 20% renewable heat. The extra overall system cost projected at ~€250 million per year will result in a saving of almost €600 million on imported fossil fuels. This will significantly increase Ireland's energy security (from an import share of 50% with current policy to 34% with a 40% renewable heat target) and create more jobs in Ireland's domestic energy sector. In addition, realising the 7% CO_2 reduction with switching over 40% of our heat supply to indigenous renewable energy sources would result in the creation of an estimated 23,000 new permanent, full-time jobs over this decade.

The 7% annual CO_2 reduction

can be achieved with renewable heat technologies readily available in Ireland and already widely deployed in EU countries which have significantly decarbonised their heating system.

The RES-H_7% scenario reflects what the sector believes can be realistically achieved with a progressive policy-framework going beyond the objectives of the 2019 Climate Action Plan (CAP) to meet the Programme for Government target of 7% annual GHG emission reduction. District heating meets 10% of the national heat demand[1] mostly with high temperature surplus heat from waste-to-energy, power plants, data centres and industry. Solid biomass plays a substantial role in industry to replace coal and oil, and in buildings requiring high temperature heating where it substitutes some oil and totally replaces peat and coal[2]. Renewable gas plays a role on and off-gas grid with biomethane and BioLPG. Heat pumps have a similar level of penetration as in current policy (CAP and NECP_WAM both include 600,000 units in homes), and also contribute to district heating using medium temperature heat sources (e.g. from data centres). This scenario puts Ireland on a stronger path for decarbonisation by 2050.

[1] In the RES-H_7% scenario, district heating supplies over 50% of the heat demand in high heat density areas in Dublin, Cork, Limerick & Drogheda. This represents an annual increase of 1% of national heat demand in DH penetration, in line with its historical growth trajectory in Scandinavian countries.

[2] This scenario requires 1.2 TWh/yr of wood chips from short rotation coppice and mobilises most of the existing forestry resource.

Rapid policy and regulatory change is required to put us on track to deliver 40% renewable heat by 2030

A detailed list of changes is included in this report, outlining how government and industry can work together to deliver a 40% renewable heat target by 2030. The list includes 21 actions for government across policy and regulation (7), financial stabilisation (11) and capacity building (3). It also includes 19 industry-led actions which the renewable heat sector is prepared to drive if an ambitious target is put in place across capacity building (7), innovation (4), quality assurance (5) and awareness-raising (3). Here are a number of highlights of cross-sectorial actions required:

1. Updating the building regulations and BER assessment methodology to accurately reflect the decarbonisation benefits of renewable heat.
2. Simplify administrative & regulatory requirements barriers, particularly in relation to financial incentives for renewable heat technologies, to increase uptake and reduce compliance costs.
3. Implement Article 23 of the Renewable Energy Directive (REDII) under the EU Clean Energy Package with a mandatory high ambition of at least 3% per annum.
4. Set Green Procurement targets for the public sector at a minimum of a 20% annual increase in renewable heat and mandate that all new or replacement heating systems to be 100% renewable.
5. Widen the support for renewable heat in the Home Energy Grants and in the Support Scheme for Renewable Heat (SSRH), and seek ways to incentivise large heat users to adopt renewable heat solutions.

The table on the next page provides key details of the cross-sectorial measures that are proposed by the members of Renewable Energy Ireland. A complete list is put forward in the main report.

Sector	Policy Improvement	Description	Aim	Lead	Supporting Role	Next Step	Target Date	Impact of Delay on 2030 targets
Buildings	**All RES-H 1** **Building Regulations Part L**	Update Building Regulations Part L compliance procedure and BER methodology to reflect properly the decarbonisation benefit of renewable heat options.	Remove Part L compliance & BER methodology barriers to the adoption of renewable heat technologies & district heating.	DHLGH	SEAI, REI RGFI, IrBEA, IrDEA	a) Cross-sectorial working group to prepare recommendations. b) Publication of revised methodology and software update. c) Raise awareness and educate BER assessors & advisors.	a) H1 2021 b) H2 2021 c) H2 2021	Decision-makers will continue to be disincentivised to adopt cost-effective decarbonisation solutions.
Cross-sectorial	**All RES-H 2** **Simplify regulatory & administrative requirements**	Terms & conditions and procedures for funding schemes to be streamlined and simplified. Accelerate digitalisation of processes. Foster a collaborative approach between funding authorities & industry.	Remove red tape and accelerate access to financial supports by consumers.	SEAI, DECC, DHLGH (Building Regulations), DAFM.	REI RGFI, IrBEA, IrDEA	a) Co-design approach to schemes administration. b) Publish joint Quality Assurance and Consumer Protection Charter. c) Investment in efficient administrative systems. d) Annual review of progress by joint steering committee.	a) H1 2021 b) H2 2021 c) H2 2021 d) Annual	Failure to mobilise private and state investment in RE technologies and continuing dependence on fossil fuels in the heat sector.
Cross-sectorial	**All RES-H 3** **Renewable Heat Obligation Scheme**	Implement Article 23 of REDII with a mandatory high ambition of at least 3% per annum.	To mandate fuel suppliers to increase the share of RES-H in their supply by 3% per year.	DECC, Department of Transport, NORA	REI, RGFI, IrBEA, IrDEA	a) Establish administrative system (certification, M&V, etc.) b) Introduction of Renewable Heat Obligation Scheme, in line with transposition of REDII. c) Annual review in CAP by steering committee.	a) H1 2021 b) H1 2021 c) Annual	Consumer carrying financial burden on lack of choice. Anti-competitiveness, non-compliance with SDG's, ESG's.
Non-residential	**All-RES-H 4** **Public sector green procurement**	Public sector to set Green Procurement targets at a minimum of a 20% annual increase in RES-H. All new or replacement of heating systems procured to be 100% renewable.	Public sector to be driver for adoption of renewable heat through green procurement policy and practices.	DPER, all public bodies.	OGP, REI, RGFI, IrBEA, IrDEA	a) Mandate an annual increasing share of renewable heating in the Green Procurement Guidance for the Public Sector. b) Establish M&V system with annual reporting.	H2 2021	Prevent 'locked in' fossil fuels in the public sector.
Tertiary & Industry	**All RES-H5** **Non-residential sectors, incl. industry & ETS sectors**	Widen and improve supports for RES-H in the non-residential sectors. Seek ways to incentivise large users of heat to adopt RES-H, including in hard to decarbonise sectors, in particular industry and ETS sector.	Support the decarbonisation of the industrial sector and encourage efficient use of RES resources.	DECC, SEAI	REI, RGFI, IrBEA, IrDEA	a) Improve and widen SSRH supports for biomass, renewable gas, heat pump and district heating systems. b) Remove carbon tax exemption for fossil-fuel based CHP. c) Increase carbon tax. d) Detailed study of ETS and non-ETS sectors on large heat users solutions.	H2 2021	RES-H remains uncompetitive, hard to decarbonise sectors lagging behind and their economic activity being impacted.
Residential	**All RES-H6** **Wider domestic grant supports**	Expand range RES-H technologies eligible for Home Energy Grants and offer more options to homeowners, including for hard to retrofit homes.	Remove barriers to adoption and incentivise a wider range of RES-H options.	SEAI, DECC	REI, RGFI, IrBEA, IrDEA	a) Incentivise bioenergy solutions and district heating substations. b) Relax max HLI requirement for heat pumps retrofits.	Budget 2022	Much of the existing housing stock will remain on fossil fuels for the foreseeable future.

1 Introduction

Heat is fundamental to our well-being, warming our homes, offices and workplaces, and is an essential ingredient in many industrial processes.

Yet, thermal energy use in Ireland was responsible for 14 million tonnes of CO_2 emissions in 2018, circa 36% of the total energy-related CO_2 emissions and 21% of the total greenhouse gas emissions[3] in Ireland (Figure 1). The national expenditure for thermal energy was estimated at €3 billion that same year. Ireland is also dependant on imports for about 65% of its thermal energy use and this is a key element of the country's vulnerability in terms of energy security.

In order to meet the government's target of 7% annual reductions in CO_2 emissions, Ireland must transition rapidly to renewable heat by supporting sustainable, efficient, economic, competitive renewable heat technologies that can deliver on security of supply. Our country has readily-available renewable energy resources and technologies to allow us the benefit of comfortable, affordable and sustainable heat. The renewable heat transition will have a large economic impact, in particular in rural communities, by redirecting the billions spent in importing fossil fuels to the production of local heat via, the installation and maintenance of clean heating technologies.

The objectives of this study are to provide a better understanding of heat demand usage, to assess the potential renewable energy resources available and to explore appropriate technical pathways to decarbonise our nation's heat supply. Following this analysis, the Renewable Heat Plan advocates a series of policy instruments and industry-led initiatives to accelerate deployment of renewable heat in Ireland.

The 40by30 Renewable Heat Plan for Ireland addresses policy-makers at national and local level, as well as stakeholders in the heat market and in the community, to demonstrate why we need radical ambition for renewable heat to help decarbonise our economy and to advocate for their support in fulfilling this ambition.

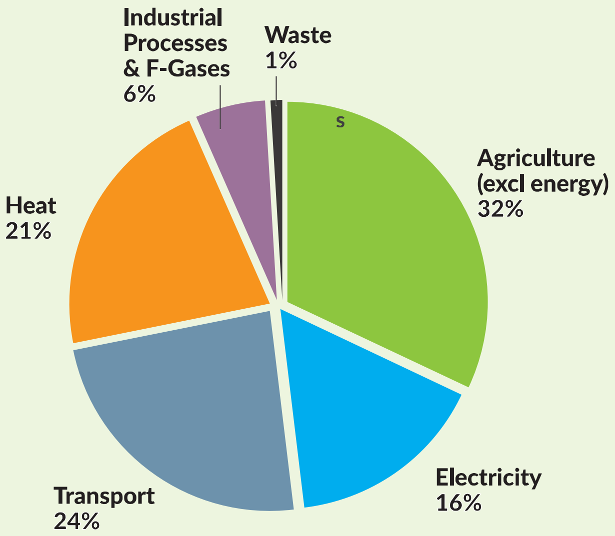


Figure 1: Breakdown of greenhouse gas emissions in 2018.

Heat is responsible for 14 million tonnes of CO_2 per year, a fifth of Ireland's greenhouse gas emissions.

[3] The national greenhouse gas emissions were equivalent to 60.5 million tonnes of CO_2 in 2018.

2

Profiling heat usage in Ireland now and in 2030

In order to plan the country's renewable heat transition, the first step is to develop a better understanding of our heat supply and to use the best projections available to develop a profile of our future heat demand.

Profiling the heat sector requires various energy accounting metrics which represent different steps along the supply chain:

Primary Energy Supply (PES): accounts for the primary energy required to produce and supply the fuels and electricity consumed for heating[4].

Final Energy Consumption (FEC)[5]: fuel going into a boiler, or the electricity going into an electrical radiator. This is also referred hereafter as thermal energy use.

Heat Requirement: end-user demand for heat i.e. the heat coming out of a boiler, a heat pump, etc.

4 For example, if electric heating is used, this is the fuel going into the power plant to produce the electricity before it is delivered to a building or industry premises.

5 This is taken as the total amount of fuels, electricity and other forms of energy (e.g. solar energy, ambient heat, geothermal heat) used to meet our heating requirement.

2.1 Overall thermal energy use

Heat represents 40% of the national energy use. 90% of Ireland's thermal energy use is from fossil fuels.

The total thermal energy use was estimated at circa 58 terawatt-hour (TWh) in 2018, according to a review of the national energy balance (SEAI, 2019). This is 40% of the total final energy consumption and 39% of the total primary energy supply. Figure 2 provides a breakdown by source and shows that oil and gas are by far the greatest source of heat. Solid fossil fuels such as coal and peat still represent 9% of our heat use. Renewable energy contributes 6.4% to which we should add 1.8% contribution from renewable electricity through direct electrical heating or heat pumps.

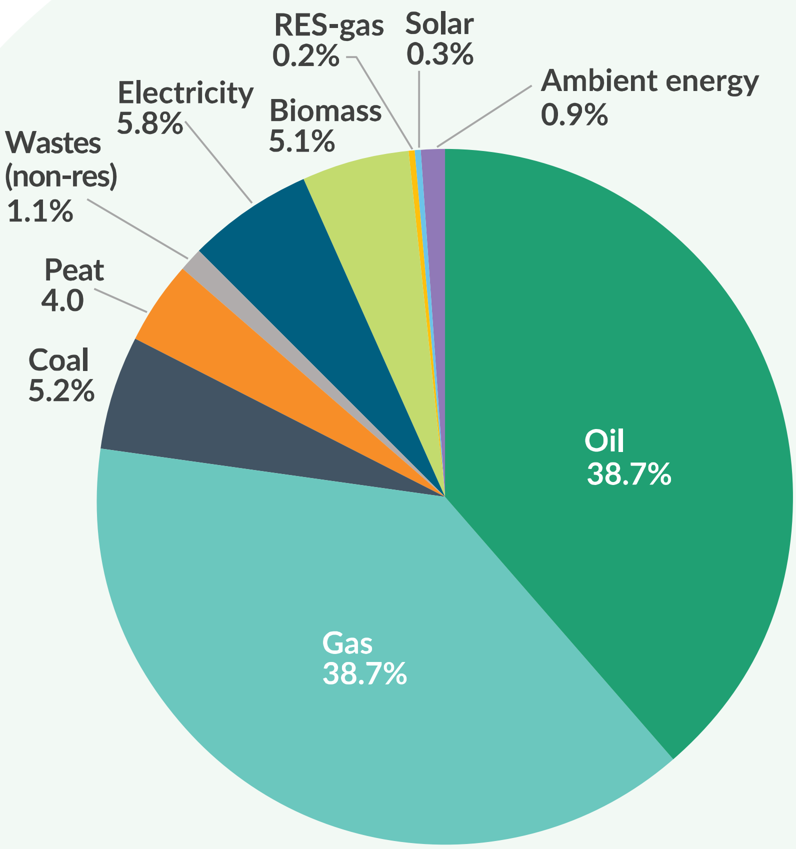


Figure 2: Breakdown of thermal energy use in 2018

2.2 Profiling today's national heat requirement

In order to assess alternatives to the current heat supply system, the analysis needs to start with the root requirement i.e. the heat produced for our space heating, sanitary hot water and industrial processes. To approximate this heat requirement, standard heat conversion efficiency factors were applied to the amounts of the different fuels contributing to the total thermal energy use (including electricity). Three characterisations were considered to profile the national heat requirement:

Sectorial, with a breakdown between residential, tertiary (private and public buildings) and industrial heat demand[6]. This is particularly useful to assess renewable heat options according to different types of heat users and market segments.

Geographical, with a breakdown between rural, suburban and urban areas. This is based on an analysis of the spatial distribution of heat demand in terms of heat density[7], and is particularly useful to assess networked heat supply options (e.g. district heating, gas grid) versus individual, decentralised options.

By temperature range, with a breakdown between low, medium, high and very high[8] temperature applications associated with space heating, domestic hot water (DHW) production and thermal processes in industry. This is useful to assess renewable heating technologies according to their ability to produce heat efficiently at different temperature levels.

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6 The share of heat demand between the different sectors follows the sectorial breakdown of the total final energy consumption in the 2018 Energy Balance (SEAI, 2019). 'Buildings' refers to the residential and tertiary sectors combined.

7 The Irish Heat Atlas published by the Irish District Energy Association was used to quantify the heat demand in buildings according to three areas of heat density levels (amount of heat demand per 100 m x 100 m plot) taken as urban (120 TJ/km2, 35% of total heat demand), suburban (50-120 TJ/km2, 20% of total) and peri-urban/rural (<50 TJ/km2) (Tobias Naegler, 2015). There was no suitable data on the spatial distribution of industrial heat demand at the time of the study and it was assumed to be 50% in rural areas, 50% in suburban areas. This is likely to underestimate the share of heat demand in urban centres.

8 The breakdown in heat demand by temperature level assumes 30% of buildings are heat pump ready (heat loss indicator < 2.3, allowing for space heating flow temperature <40 ºC) and 45% of buildings can operate their heating systems at 60 ºC or less, and the balance at 100 ºC or less. For the industrial sector, the temperature level breakdown follows the results of the study "Quantification of the European industrial heat demand by branch and temperature level" (Tobias Naegler, 2015).

Over 2/3 of the national heat demand is in buildings, at a temperature which can readily and cost-effectively be met with renewable heat solutions.

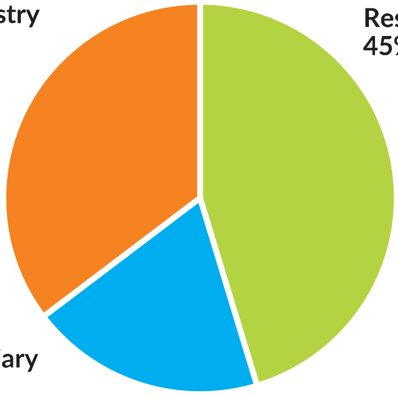


Figure 3:
Breakdown of heat demand by sector

Industrial processes at high temperature are the backbone of our economy and will require focused solutions for decarbonisation. 50% of the national heat demand is in urban and sub-urban areas, with plenty of scope for district heating and renewable gas deployment.

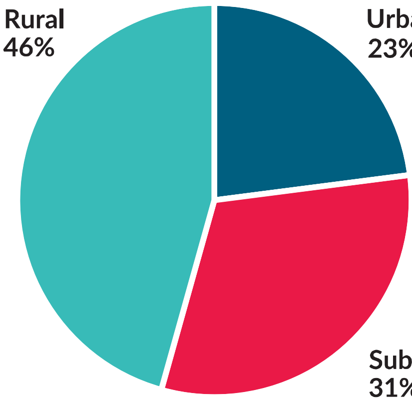


Figure 4:
Breakdown of heat demand by geography

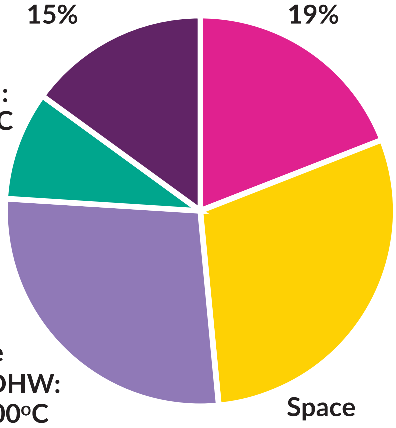


Figure 5:
Breakdown of heat demand by temperature

The key findings of this heat demand profiling are that, out of a total estimated heating requirement of 45 TWh/year, buildings have the largest share but that industry represents more than a third. While Ireland has a relatively low density of population, over 50% of the heat demand is relatively concentrated. Also, approximately three quarters of our heat demand is at a low temperature, but process heat has a significant share that requires renewable heat solutions capable of producing high temperatures. It is worth noting that while heat usage in buildings is generally well understood, there appears to be a gap in knowledge of heat demand in industry in Ireland. This will need to be addressed to be able to enable the development of appropriate policy responses for its decarbonisation and the planning of the industrial sector's energy transition.

2.3 Projecting heat demand up to 2030

Following the baseline analysis above, the next step was to forecast the future heat demand before assessing different technological pathways of renewable heat supply. It was assumed that the 'With Additional Measures' (WAM) scenario in the most recent National Energy and Climate Plan (NECP) 2021-2030 (DECC, 2020) provides a strong basis to project future heat demand. This NECP_WAM scenario considers the impact of the current policy framework in terms of heat demand reduction through energy efficiency, combined with the projected impact of future social and economic trends[9]. As in the baseline analysis, fuel to heat efficiency factors were applied to the final energy consumption figures to establish the associated heat demand for 2030, considering the projected fuel mix in the NECP_WAM scenario.

Figure 6 to Figure 8 below compare the profiling of heat demand variation between 2018 and 2030. These projections anticipate important changes in the profile of heat demand by 2030. Despite a 12% reduction in residential heat demand due to energy efficiency, the overall heat demand is expected to grow by 14%, to 51 TWh/yr, driven by industry (+48%) and the tertiary sector (+18%) in line with economic activity forecasts for these two sectors. Significant increase of "heat pump ready" (from circa 30% to 65%) are assumed following the high levels of energy retrofits considered in this NECP_WAM scenario. The growth in industrial heat demand is also reflected in the larger share of high temperature applications (+6% in share of total heat demand). Please note that no changes in the spatial distribution of heat demand were assumed, however it is likely that increased urbanisation will lead towards a shift of heat demand towards higher heat density areas.

Heat demand is projected to grow by 14% over the next decade, driven by the industrial and services sectors.

Decarbonising process heat, using bioenergy and electro-thermal solutions, will be an important driver for renewable heat development. However, improvements in buildings' efficiency will facilitate the deployment of low-temperature systems such as heat pumps.

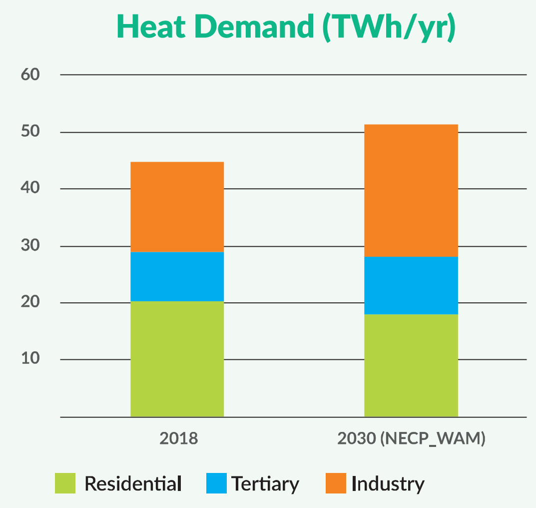


Figure 6: Projections heat demand by sector 2018-2030

[9] These projections, based on the ESRI COSMO and I3E models, forecast relatively low future energy costs, carbon taxes (€80/tCO_2), close to 50% growth in GDP and GVA, 10% growth in population.

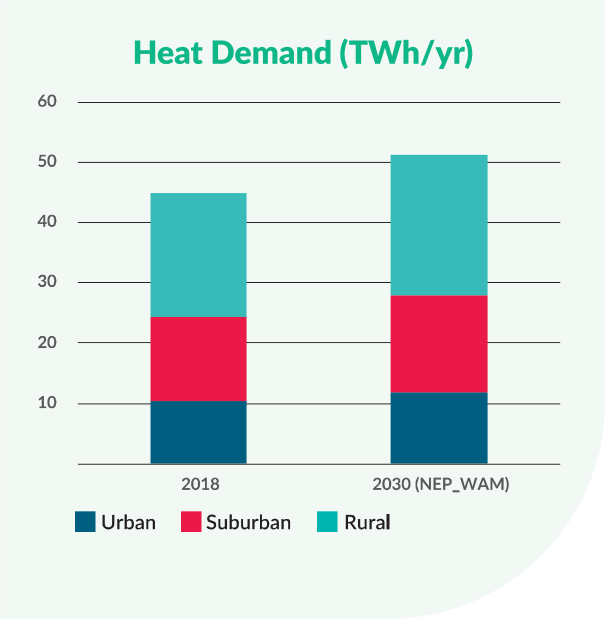


Figure 7: Projections heat demand by density 2018-2030

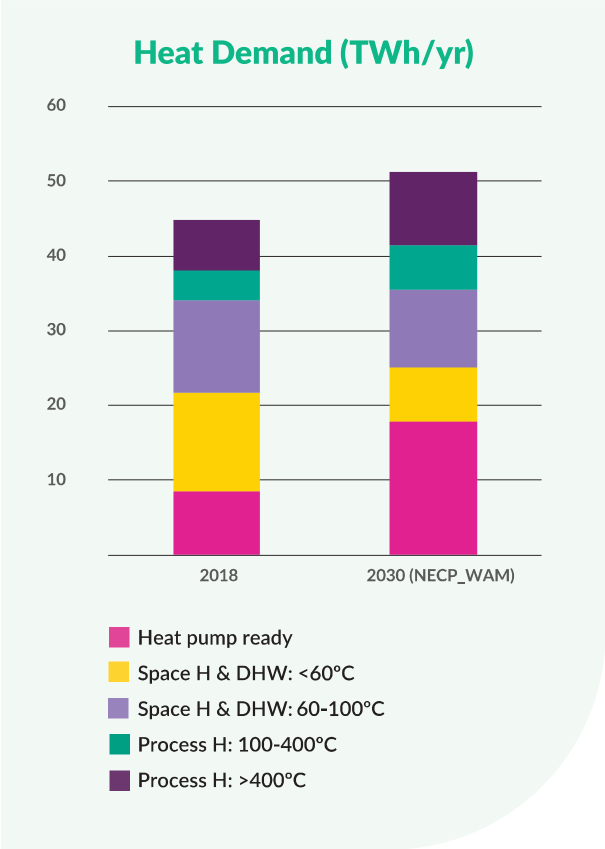


Figure 8: Projections heat demand by temperature 2018-2030

The heat demand profiling undertaken as part of the study provides a good basis to assess renewable energy options for decarbonising heat. As homes become more suitable for low-temperature heating due to improve energy efficiency standards, the opportunity for heat pumps in new and existing homes will grow, in particular for areas with low heat density. Where the required investment in building retrofit is not assured, biomass heating systems using wood fuels or renewable gas can offer a cost-effective decarbonisation option. The substantial share of high heat density areas provides strong opportunities for district heating to play a much bigger role in servicing towns and cities, in particular for buildings requiring higher heating temperatures (typically up to 80°C).

Decarbonising thermal processes in industry will be very challenging and high temperature renewable technologies using solid biomass and renewable gas could play a key role in this regard, possibly with thermo-electric systems. These options are considered further hereafter in terms of the availability of renewable resources and the feasibility of different technological pathways.

3

Potential renewable energy resources available to decarbonise heat

A comprehensive literature review was undertaken to assess the potential renewable energy resources for the production of renewable heat in Ireland.

This was complemented with data provided directly by the study partners and representatives from the sector. The key objectives of this assessment was to identify the resources that are accessible[10] and can realistically be harnessed in Ireland in a cost-effective way by the end of the decade. Imported resources that already have a market in Ireland have been considered. For each resource, the primary energy costs, the associated heat production technologies and their key characteristics have been outlined.

[10] Generally, the study considered the definition of 'accessible' potential as per SEAI's LARES methodology technical resource, but constrained by practical and physical incompatibilities, and constrained by institutional or regulatory deletions, which limit RE extraction (SEAI, 2013).

3.1 Bioenergy

Bioenergy refers to the use of biomass, which can be used directly or transformed into biogas and biofuels, to produce energy.

Biomass is defined in the RE Directive as the biodegradable proportion of products, waste and residues from agriculture (including vegetal and animal substances), forestry and related industries, including fisheries and aquaculture, and the biodegradable fraction of industrial and municipal waste.

The revised Renewable Energy Directive (REDII) published by the EC in 2018 introduces the Sustainability Criteria, requiring among others that i) biomass is not sourced from lands that will not be replanted, ii) sensitive areas are protected, iii) forest carbon stocks remain stable or increase across the sourcing region, and that iv) harvesting respects biodiversity and soil quality. The Directive also imposes further requirements to minimise the risk of using forest biomass derived from unsustainable practice. All these criteria are subject to third party verification.

Where bioenergy is sourced from sustainably managed land resources and processes, and is included within an economy-wide greenhouse gas accounting system, carbon dioxide emissions on combustion of biomass are accounted as zero[11].

Among other renewables, bioenergy rollout is particularly effective in the creation of permanent employment in the harvesting, transport and processing of biomass, as well as the production of biogas. Rural communities in particular are well placed to participate in such activities, through direct and indirect employment and wealth creation.

The study considered two main sources of biomass appropriate for thermal applications, solid biomass suitable for combustion (e.g. wood fuel) and renewable gas produced from the anaerobic digestion (AD) of organic waste (e.g. from food processing, municipal waste, farm wastes, etc.) or other chemical processes (e.g. BioLPG as a by-product of biofuel production). Please note that where potential resources estimates are provided, they refer to the energy content of the biomass fuel (solid biomass, biogas/biomethane, BioLPG, etc.), before they are converted to heat.

[11] IPCC approach to greenhouse gas emissions from combustion of biomass) at the national level, which allows for complete coverage of emissions and sinks, and involves all IPCC sectors, including in particular, Energy, Agriculture, Forestry and Other Land-Use (AFOLU), and Waste. Carbon dioxide emissions from the combustion of biomass are captured within the CO_2 emissions in the AFOLU sector through the estimated changes in carbon stocks from biomass harvest, even in cases where the emissions physically take place in other sectors (e.g. energy) (Calvo Buendia E, 2019).

3.1.1 Solid biomass

Ireland now has a sizable forest resource, with a growing wood component. In particular, thinning material harvested during the early stages of growth and harvest residues can be mobilised to meet increasing levels of biomass demand in line with sustainable forest management. In addition, Ireland has an excellent climate for tree growth and, with its low population density, a sizable resource of land suitable for the production of biomass fractions to grow through forest establishment and management, and to a lesser extent, establishment of bespoke short rotation coppice and forest crops. Solid biomass can be stored long-term when dry and can be used on demand. The primary solid biomass resources considered were:

Indigenous Forestry and wood processing residues: 11% of the national land area is afforested (c. 770,000 ha, 50% in public ownership), mostly with conifers (70%) (DAFM, 2020). The Irish Bioenergy Association (IrBEA), considering forecasts by COFORD (2018), estimates that over 4.5 million m^3 of forestry and wood processing residues will be suitable for bioenergy by 2030, resulting in an accessible biomass potential of 6.3 TWh/yr from existing forestry. Another 0.4 TWh/yr will be available from Post-Consumer Recovered Wood (PCRW).

Short rotation coppice and short rotation forestry: an ambitious programme of planting willow short rotation coppice (2-3 year harvest rotation) and short rotation forest (8-20 year harvest rotation) could result in a total dedicated wood energy crop resource of 150,000 ha within 15 years, capable of yielding 3 TWh/yr of biomass fuel by 2030 and 6.7 TWh/yr in 2035.

This solid biomass resource can be available in the form of roundwood, wood chips and wood pellets. Good quality, dry wood fuels combusted in clean and efficient appliances such as stoves and automated boilers are a suitable option for less efficient buildings requiring higher heating temperatures, in low heat density areas. They are also suitable for industrial applications or district heating, particularly to meet thermal base loads with highly efficient boilers or combined heat and power (CHP) plants.

3.1.2 Renewable gas

Renewable gas can be produced from a range of biomass resources readily available in Ireland. Anaerobic digestion is a well proven pathway to convert organic matter into biogas which can be burned in a gas boiler or combined heat and power unit. Biogas can also be upgraded to biomethane (a direct substitute for natural gas) which can be stored, transported, injected into the gas grid or used in off-grid applications. Biomethane can also play an important role as a transport fuel.

The following biomass resources were considered for the production of biogas:

Slurry and manure from cattle, pigs, poultry, etc. with published potential resource estimates varying from 0.7 TWh/yr (Ricardo, 2016) to 1.4 TWh/yr (Richard O'Shea, 2017).

Grass silage is also an excellent AD feedstock with a very significant potential, which can be derived from increasing grass production above current needs for animal grazing, and/or possibly as an alternative use of grass in the context of farm diversification. Published potential resource estimates indicate a potential varying from c. 8 TWh/yr (Ricardo, 2016). However, silage feedstock is an expensive feedstock and O'Shea (2017) estimates that the economically viable potential is circa 3.4 TWh/yr for grid-injection.

Segregated food waste from brown bin collections and from industrial food production is also an interesting feedstock, with the production of biogas as part of a circular waste management approach, and the additional advantage of potentially attracting gate fees. The potential resource is estimated at 0.6 TWh/yr.

The total potential from these forecasts varies from 4.7 to 10 TWh/yr. Other projections for the potential production of biomethane were provided by the participating trade associations, including:

IrBEA and Cre advocate for a medium-term target of 1.6 TWh/yr for biomethane in line with the Climate Action Plan Ireland (IrBEA & Cre, 2019). This should be mobilised on a phased basis in the medium term.

In their analysis for the RGFI, KPMG proposes an ambitious programme comprising 225 Agri-based AD plants (feedstocks comprising 60% silage, 40% slurry) and 11 commercial waste plants operational by 2030, with a potential production of 5.6 TWh/yr of biomethane. These projections are based on the RGFI/KPMG Integrated Business case for Biomethane in Ireland 2019. (KPMG, 2019).

Other biomass resources which can be considered for the production of renewable gas include:

The organic fraction of **residual municipal solid waste** (1.13 TWh/yr according to Riccardo, 2016) which can be used in waste-to-energy plants, for anaerobic digestion or in thermo-chemical processes such as pyrolysis or gasification to produce renewable gas.

Tallow (animal fat) is a food industry by-product (0.80 TWh/yr) which can be used to produce biodiesel, with BioLPG as a by-product.

BioLPG is currently a co-product of biofuel production using plant oils, but it can also be produced from bio-residues in agriculture & forestry (gasification plus Fischer Tropsch process) as well as from food processing residues and plant oil. Liquid Gas Ireland (LGI) projects that BioLPG has a potential of 0.46 TWh/yr produced from indigenous resources by 2030, and a further 1.05 TWh/yr from imported sources.

3.2 Electrification of heat

With rapidly increasing shares of renewable energy in electricity production, the electrification of heat is a central pillar of the national and European strategy for decarbonisation.

In 2018, 33% of the electricity produced in Ireland was renewable, with an average carbon content of 375 gCO_2/kWh (SEAI, 2019). By 2030, the target is to grow to 70% renewable electricity (DECC, 2019), with an average carbon content of 118 gCO_2/kWh[12].

Heat pumps are a very efficient form of electrical heating. They harness 'ambient heat' sources such as air, water bodies and the ground, using a refrigeration cycle to upgrade their temperature to levels suitable for thermal applications, typically central heating in homes and tertiary buildings. Most heat pumps are driven by electricity, and it is expected that for each unit of electricity used, between 3 and 4 units of heat are produced (with a share of renewable ambient heat between 66% and 75%). Considering the projected carbon content of electricity by 2030, this would result in at least 80% reduction in CO_2 emissions compared to oil heating.

The WAM scenario of the NECP forecasts up to 6.5 TWh/year production of renewable heat from heat pumps (DECC, 2020), based on the Irish Government's Climate Action Plan (2019) target of 600,000 domestic heat pumps installed by 2030. The Geothermal Association of Ireland projects that ground-source heat pumps retrofitted in tertiary buildings could have a total thermal capacity of 200 MW by 2030, with the potential to produce 300 GWh/yr.

In addition, **large surface water bodies** (rivers, lakes, seawater) and **grey water** from the sewage systems are ideal renewable heat sources for heat pump applications in conjunction with district heating, with a technical potential estimated at 1.4 TWh/yr (Persson U, 2014/2019).

With 70% renewable electricity penetration targeted for 2030, largely from intermittent sources such as wind and solar energy, the electrification of heat can play an important role in balancing the electricity grid. At anticipated annual '**dispatch-down**' of intermittent renewable generation of 10% is assumed for 2030, which could be conservative considering it is already 11.4% today[13], so the available surplus electricity would be in the order of 2.8 TWh. If this surplus electricity is harnessed by heat pumps with an efficiency of 300%, combined with thermal storage, 8.5 TWh of renewable heat could be produced very cost-effectively as part of a demand-response strategy. This can be achieved with a multitude of decentralised heat pumps or with large, centralised heat pump systems combined with large thermal stores and district heating.

[12] Assuming carbon intensity in the 2030 Base Case Scenario (70% renewable electricity penetration) modelled by the EAI/MaREI in the "Our Zero eMission Future" study (Dr Paul Deane, 2020).

[13] 2020 EirGrid Annual Dispatch Down report indicates levels of 11.4% for Ireland: https://www.eirgridgroup.com/site-files/library/EirGrid/2020-Qtrly-Wind-Dispatch-Down-Report.pdf

3.3 Surplus heat

A number of sources of surplus heat have been considered as part of this assessment of renewable heat available:

Waste-to-energy plants operating in combined heat and power mode, such as the Covanta Plant in Poolbeg, with a surplus heat potential estimated at 1.9 TWh/yr by 2030 (IrDEA, 2020).

Data centres are a rapidly growing segment of the Irish economy and energy system, with forecasted electricity demand of 1400 MW by 2030. The surplus heat available from these data centres' ongoing cooling has a potential estimated at 6.1 TWh/yr by 2030 (IrDEA, 2020).

Surplus heat from industrial processes is not only a great way to get carbon neutral heat for district heating, but it can increase the attractiveness of industry to a location[14]. Industry surplus heat in Ireland has been estimated at 4.4 TWh/yr (Persson U, 2014/2019).

Currently, the vast majority of power plants are releasing heat equivalent to 40% of their fuel input into the atmosphere or in adjacent water bodies. The theoretical potential for recovering **heat as a by-product from power stations** has been estimated at 8.7 TWh/yr for 2030[15] (IrDEA, 2020).

This surplus heat can potentially play a very significant role in supplying low-carbon, low-cost heat to many urban centres in Ireland with district heating.

[14] For example, the Kemira sulphuric acid plant in the city of Helsingborg in Sweden (population ~108,000) supplies one-third of the cities heat demand from heat that would otherwise be discarded, which benefits the city but also created an additional revenue stream for the company making the city a more attractive location. See http://www.euroheat.org/wp-content/uploads/2019/09/Helsingborg_DHCities.pdf for further details.

[15] The adequacy and availability of waste heat from power plants in a 70% renewable electricity system, with a lower number of operating hours for gas turbines should be further investigated to ascertain its practical potential.

3.4 Other accessible resources of renewable heat

The potential of other sources of renewable heat was considered as part of this assessment, including:

Deep geothermal energy: Although Ireland does not possess high temperature geothermal reserves, there is the potential to use low enthalpy resources located in or near high heat density areas such as in the Greater Dublin Area, for applications such as district heating or on specific commercial and industrial sites with intensive thermal processes. The Heat Roadmap Europe study indicates that the geothermal resource suitable for district heating is 3.2 TWh/yr (Persson U, 2014/2019). The Geothermal Association of Ireland projects that the industry could deploy a total of 23 MW of installed thermal capacity by 2030, resulting in the production of 91 GWh/yr of renewable heat (GAI, 2020).

Solar thermal energy is already well established in Ireland for the production of domestic hot water in individual buildings. Large solar thermal systems are also making a substantial contribution to district heating in countries like Denmark, Austria and Germany. For example, the town of Marstal in Denmark produces over 50% of its heat annually using large-scale solar and thermal storage on a district heating scheme[16]. The potential of solar district heating has been estimated at 3.6 TWh/yr by 2030 (Persson U, 2014/2019).

[16] http://co2mmunity.eu/wp-content/uploads/2019/03/Factsheet-Aer%C3%B6-Marstal.pdf

3.5 The overall potential of renewable heat resources accessible

Overall, the renewable energy resources accessible for heat supply in Ireland, as identified above, have a total potential forecasted at 67 TWh/yr for 2030 (see summary of breakdown in Table 1 below), of which biomass has the biggest share (solid biomass, biogas and biofuel combined at 34%), followed by surplus heat (32%[17]), and the electrification of heat (25%). If an average heat production efficiency of 90% is assumed across the different renewable heating technologies available (biomass boilers, heat pumps, district heating, etc.), this renewable heat resource could produce 60 TWh/yr of useful heat. This compares to a total national heat demand forecast of 51 TWh/yr by 2030, demonstrating that Ireland could meet its heating requirement with 100% indigenous clean energy.

Table 1: Accessible potential of renewable heat resources considered in the study.

Renewable heat resource potential	TWh/yr	%
Indigenous forestry & energy crops	9.7	15%
Tallow, residual MSW, BioLPG	2.4	4%
Biogas/Biomethane	10.0	15%
Surplus heat	21.1	32%
Electrification of heat[18]	16.7	25%
Other renewable heat resources	6.8	10%
Total	**66.7**	

Ireland is endowed with sufficient renewable energy resources to meet 100% of its total heating requirement, and more.

[17] If the full theoretical potential of waste heat from power plants is considered.
[18] This includes the heat which could be produced from green electricity which is expected to be lost or 'dispatched down' in Ireland in a 2030 power system with 70% renewable electricity.

3.6 The role of energy networks to support the renewable heat transition

Energy supply networks provide an essential infrastructure for the transition to renewable heat, enabling the distribution of thermal energy from sources of production to the end-users and the integration of different energy systems. The electricity and the gas networks are the well-known incumbents in this regard, but the decarbonisation of the energy system will require adaptation and innovation.

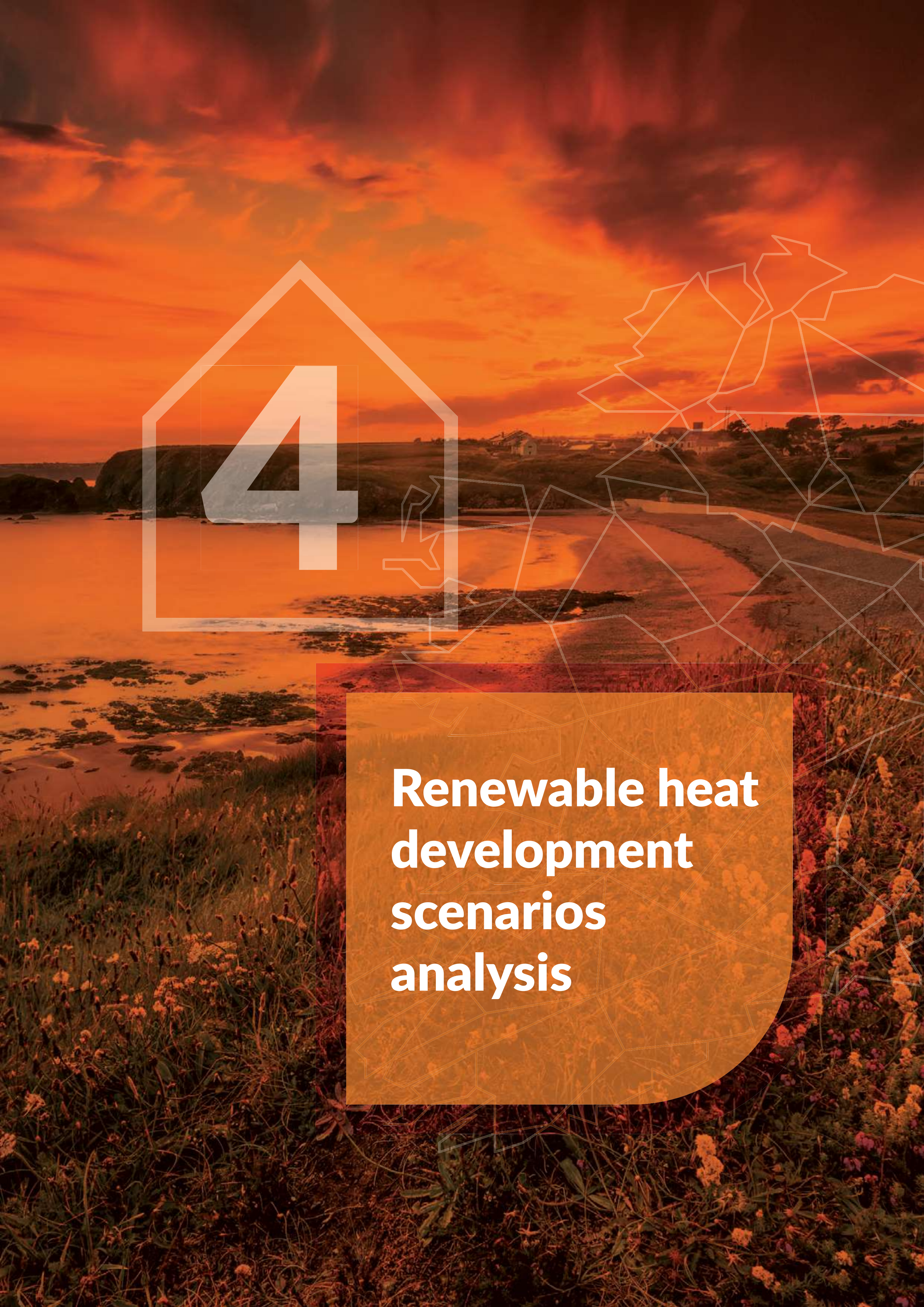
District heating (DH) networks offer a different model of heat supply, using a hot water pipe network to distribute heat from centralised heat producers to heat consumers, enabling the large-scale substitution of the incumbent individual fossil-fuel based heating systems. A key criteria for district heating systems to be economically viable, given the large capital cost associated with the heat production and supply infrastructure, is the heat density[19] of the areas to be served by district heating systems.

Table 2 below presents the results on an analysis conducted for the Irish District Energy Association (IrDEA) by experts involved in the Heat Roadmap Europe projects (https://heatroadmap.eu/) on the spatial distribution of heat density in Ireland and the associated potential for district heating applications[20]. This analysis indicates that 35% of the heat demand is at a sufficient heat density for district heating to be highly feasible and feasible with current technology. District heating would be feasible for another 21% of the heat demand with the deployment of the most advanced technology. In this study, it is assumed district heating could reach 10% of the building heat demand by 2030 and a maximum of 35% longer-term, which is relatively conservative considering the potential.

Table 2: Spatial heat density distribution & district heating feasibility.

	Heat Density (TJ/km2)	Share of heat demand	Economic feasibility of DH
Rural & peri-urban	<20	35%	Not feasible
Sub-urban	20-50	8%	Not feasible yet
	50-120	21%	Feasible w. 4th generation DH
Urban	120-300	27%	Feasible w. current technology
	>300	8%	Highly feasible

[19] The higher the heat density, the shorter the pipe network required to service a given amount of heat, and therefore the lower the investment.
[20] For details of the Irish Heat Atlas and the above analysis, please visit https://districtenergy.ie/heat-atlas



4

Renewable heat development scenarios analysis

To determine the level of ambition for 2030, a cost-benefit analysis of different scenarios of renewable heat development in Ireland was carried out, considering Ireland's heat profile (as presented in section 2), the renewable energy resource available (as presented in section 3), their life cycle cost and their impact on decarbonisation (as presented in this section).

The approach and findings are presented below.

4.1 Overview of the modelling approach

A techno-economic model was created to enable a discounted cash flow analysis of different renewable heat deployment scenarios, each combining selected heating technologies using the renewable resources identified in the previous section. A scenario is defined by setting the percentage of the 2030 heat demand to be met by each of the renewable heat technologies, in the three sectors (residential, tertiary and industry). The sum of these renewable heat contributions is aggregated across the sectors to determine the overall renewable heat supply of a scenario.

The nominal capacity of the renewable heating systems to be installed is calculated, considering the amount of heat to be produced, their efficiency and the expected load factor[21]. The capital and operation & maintenance (O&M) costs are estimated by multiplying the installed capacity required by specific capital investment and operating expenditure factors (€/kW and €/kW/yr respectively). The capital cost of each system is then annualised using a discount rate of 5% over its lifetime.

Annual energy costs are calculated on the basis of projected unit costs and fuel & electricity consumption. Annualised capital costs, O&M costs and energy costs are added to calculate the total annual cost of each type of renewable heating system and aggregated across the three sectors for the modelled scenarios.

The energy costs of the incumbent heating systems[22] are added to the new renewable heat systems to calculate the annual 'whole-system' cost to meet the national heat demand in each scenario.

The quantity of energy (fuels, electricity, surplus heat) consumed in each scenario is multiplied by the relevant carbon intensity ($kgCO_2/kWh$) to calculate the amount of CO_2 emissions of each scenario. Bioenergy fuels are taken as carbon neutral, electricity is assumed to have a carbon intensity of 0.118 $kgCO_2/kWh$ and an average of 0.018 $kgCO_2$ per kWh is assumed for the surplus heat supplied.

The assumptions underlying the analysis (specific capital O&M costs, energy costs, system efficiencies, etc.) are summarised in Annex 2.

[21] Equivalent 'nominal capacity' operating hours of a heating system divided by the number of hours in a year.

[22] 'Incumbent' systems include the renewable heating systems already accounted for in the baseline scenario and the fossil fuels required to meet the balance of the heat demand (total heat demand – heat supplied by existing and new renewable systems).

4.2 Outline of the scenarios modelled

The following scenarios were modelled to compare different levels of renewable heat ambitions and different technological pathways.

The 2018 heat usage analysis is taken as the baseline, and the following scenarios were built to meet the projected heat demand for 2030.

NECP_WAM: this scenario replicates the NECP's 'With Additional Measures and Low Energy Costs' scenario, with significant gains in energy efficiency in housing, and reflecting the Climate Action Plan's ambitious targets for heat pumps in buildings. Biomass supply contributes to industrial heat demand, and to a lesser extent in tertiary buildings. Biomethane plays only a modest role.

RES-H_7%: this scenario reflects what the sector believes can be realistically achieved by 2030 with a progressive policy-framework going beyond the objectives of the Climate Action Plan to meet the Programme for Government Target of 7% annual GHG emission reduction. District heating meets 10% of the national heat demand[23] mostly with high temperature surplus heat from, waste-to-energy and power plants, data centres and industry. Solid biomass plays a substantial role in industry to replace coal and oil, and in buildings requiring high temperature heating where it substitutes some oil and totally replaces peat and coal[24]. Renewable gas plays a more modest role, in line with the Irish Bioenergy Association (IrBEA) projections for farm-based biogas production, and the use of BioLPG to substitute liquid and solid fossil fuels in off-gas grid applications. Heat pumps have a similar level of penetration as in NECP_WAM (600,000), and also contribute to district heating using medium temperature heat sources (e.g. from data centres). This scenario puts Ireland on a stronger path for decarbonisation by 2050.

RES-H_Max: this scenario represents a radical ambition for the transformation of the heating sector, leveraging a much larger share of the accessible renewable resource potential to further decarbonise it. It builds on the RES-H_7% scenario and assumes that district heating is deployed in all high density areas and meets 35% of the residential and tertiary heat demand. District heating sources its heat from high-temperature sources (70%, surplus heat and deep geothermal), and from low-temperature surplus heat sources in combination with heat pumps (25%, from data centres, grey water and rivers), and some biomass (5%)[25]. RES-H_Max also provides for a very ambitious renewable gas supply, in line with the RGFI projections for 2030 which includes tripling the use of BioLPG for rural heat and in industrial applications. This scenario represents a forceful response to the climate emergency and is a step further in achieving net zero carbon status at national level by 2050.

Electricity plays an important role in the above scenarios, to drive heat pumps and to a lesser extent for direct electrical heating. The renewable share of electricity projected for 2030 (70%) is also accounted for as part of the overall contribution of renewable energy to the national heat supply.

The balance of heat demand not met from renewable sources in each scenario was allocated to fossil fuels, prioritising the displacement of high-carbon intensity fuels.

[23] In the RES-H_7% scenario, district heating supplies over 50% of the heat demand in high heat density areas in Dublin, Cork, Limerick & Drogheda. This represents an annual increase of 1% of national heat demand in DH penetration, in line with its historical growth trajectory in Scandinavian countries.
[24] This scenario requires 1.2 TWh/yr of wood chips from short rotation coppice and mobilises most of the existing forestry resource.
[25] Please note that an additional 10% of the heat demand is accounted for through distribution losses along district heating networks.

4.3 Scenario analysis results

The results of the modelling for the scenarios described above were compiled to provide a comparative analysis on the basis of the following KPIs: CO_2 emissions, final energy consumption, renewable energy penetration, energy costs, capital cost, annual whole-system cost, Levelized cost of energy (LCOE)[26], CO_2 abatement cost. The following sections of the analysis present the results aggregated across the residential, tertiary and industrial sectors. The detailed breakdown per sector is available in Annex 1.

4.3.1 CO_2 emissions

Table 3 and Figure 9 present the breakdown of energy-related CO_2 emissions across all the scenarios. They indicate that 6 million tonnes of CO_2 have been avoided with scenario RES-H_7%, and 9 million with scenario RES-H_Max, compared to 2018 levels. That's a 48% and 67% reductions of emissions in the heating sector respectively, 17% and 24% reductions in energy-related emissions, or 10% and 15% reductions in overall national greenhouse gas emissions. These CO_2 emission reductions have been achieved despite a projected 14% growth in heat demand between 2018 and 2030. The displacement of coal, peat and oil in heating also means significant improvements in air quality, in particular in urban areas.

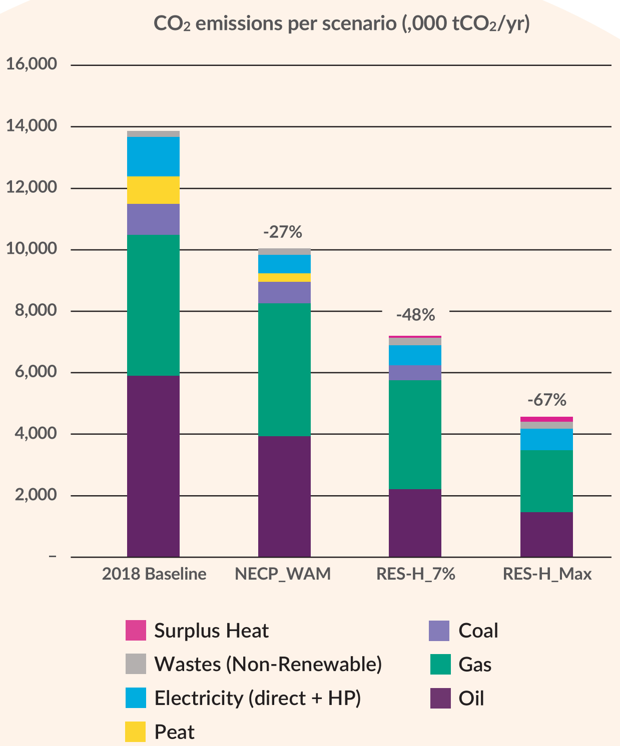


Figure 9: CO_2 emissions per scenario.

Renewable heat can play a key role in meeting the Programme for Government target of annual 7% GHG reduction, and put Ireland on a strong footing to achieve zero-carbon status by 2050.

[26] Levelized cost of energy is calculated by dividing the total annual 'whole-system' cost (incl. annualised capital cost) by the amount of energy supplied by the system, in this case 'useful heat'.

Table 3: Breakdown of CO_2 emissions per scenario.

CO_2 emissions	2018 Baseline ($ktCO_2/yr$)	2030 Scenarios NECP_WAM ($ktCO_2/yr$)	2030 Scenarios RES-H_7% ($ktCO_2/yr$)	2030 Scenarios RES-H_Max ($ktCO_2/yr$)
Oil	5,895	3,935	2,244	1,478
Gas	4,585	4,333	3,521	2,016
Coal	1,031	673	488	–
Peat	881	306	–	–
Electricity (direct + HP)	1,291	597	661	695
Wastes (Non-Renewable)	168	204	229	229
Surplus Heat	–	–	50	137
Biomass	–	–	–	–
RES-gas mix	–	3.64	9	8
Solar	–	–	–	–
Ambient energy	–	–	–	–
Total	13,851	10,052	7,202	4,563

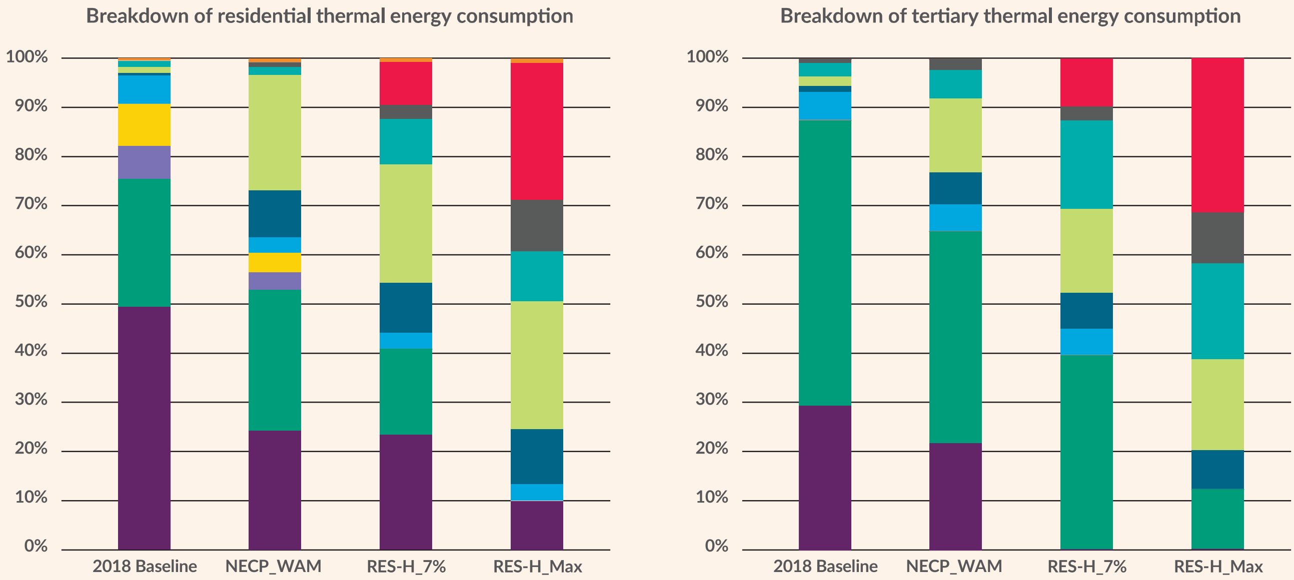
4.3.2 Final energy consumption

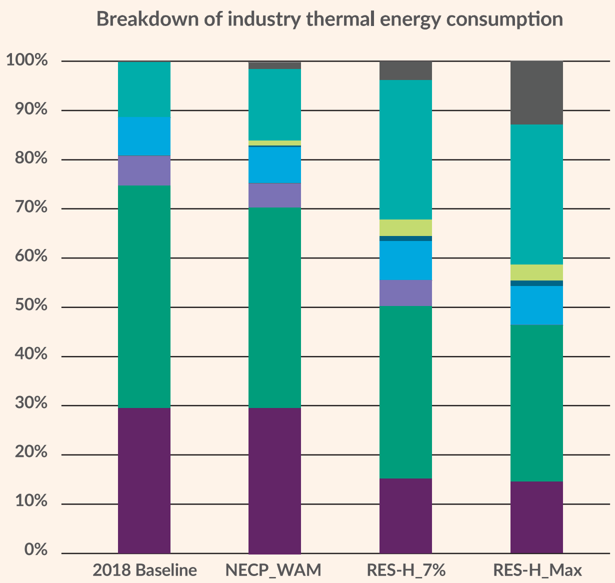
Table 4 presents the breakdown of final energy consumption across all the scenarios, with a more detailed breakdown for the residential, tertiary and industrial sectors presented in Annex 1. They highlight the potential for a significant increase in renewable heat penetration[27] from current levels of just above 6% (half the 2020 target) to 22% by 2030 under the current policy framework, to c. 40% with the ambitious RES-H_7% scenario and c. 60% with the radical RES-H_Max scenario. Figure 10 illustrates how the thermal energy mix evolves in each sector from the 2018 to 2030 scenarios, with a gradual phasing out of fossil fuels and dominance of renewable heat. Further details on the sectorial thermal energy mix of each scenario is provided in Annex 2.

Further details on the share of each energy source's contribution to meeting the heating requirements of each sector, for the scenarios analysed, are presented in the tables in Annex 3.

These levels of renewable penetration increase by another 6-7% across all advanced scenarios if the contribution of renewable electricity to heating is accounted for, but this is not included here in the overall renewable heat share to avoid double counting. Given that the share of imported heating fuels has been reduced to an estimated 34% and 17% in the RES-H_7% and RES-H_Max scenarios respectively, from 64% in 2018. Ireland is now in a much stronger position in terms of energy security.

[27] Surplus heat is considered as renewable heat for the purpose of the analysis.





The ResH_7% scenario demonstrates that an ambitious target of 40% renewable heat by 2030 is both practical and realistic, displacing imported fossil fuels with indigenous resources.

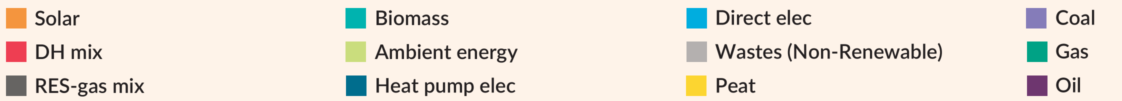


Figure 10: Share of energy sources in the overall final energy consumption of the residential, tertiary and industrial sectors.

Table 4: Breakdown of final energy consumption across all scenarios modelled.

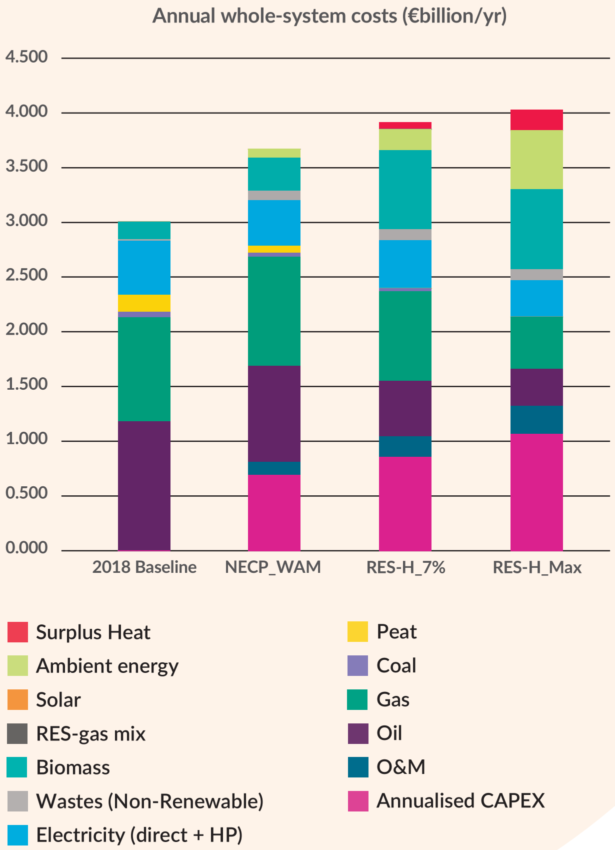
		2030 Scenarios		
Total final enegy consumption	2018 Baseline (TWh/yr)	NECP_WAM (TWh/yr)	RES-H_7% (TWh/yr)	RES-H_Max (TWh/yr)
Oil	22.43	14.97	8.54	5.62
Gas	22.40	21.17	17.20	9.85
Coal	3.03	1.98	1.43	–
Peat	2.30	0.80	–	–
Wastes (non-res)	0.64	0.78	0.87	0.87
Electricity (direct)	3.11	2.37	2.47	1.86
Electricity (heat pumps)	0.26	2.69	3.09	3.25
Surplus heat & deep geothermal	–	–	2.82	8.10
Biomass	2.93	4.83	11.66	12.14
RES-gas	0.11	0.79	1.86	6.37
Solar	0.16	0.16	0.16	0.16
Ambient energy	0.51	6.56	7.40	7.40
RES-heat	***3.72***	***12.34***	***23.90***	***34.17***
RES-e total	***1.01***	***3.54***	***3.89***	***3.58***
Fossil fuels & electricity	53.15	41.21	29.71	17.88
Grand total (incl all RES)	57.88	57.09	57.50	55.63
RES-Heat (%)	***6.4%***	***22%***	***42%***	***61%***
RES-Heat + RES-e (%)	***8.2%***	***28%***	***48%***	***68%***
Imported fuels	***64.2%***	***50%***	***34%***	***17%***

4.3.3 Whole-system annual costs and capital costs

Figure 11 and Table 5 provide a breakdown of the annual whole-system costs per scenario, including energy expenditure, CAPEX and OPEX. This gives an insight into the economic cost of the national heat supply systems and its decarbonisation. First, the modelling results indicate that future annual whole-system costs of the NECP-WAM, RES-H_7% and RES-H_Max scenarios are broadly in line[28], ranging from €3.7 to €4 billion per year[29].

[28] Please note that the capital and O&M costs of incumbent systems have not been factored in the annual whole-system cost analysis of the different scenarios. This somewhat underestimates the cost of scenarios with a higher share of fossil fuel systems which need to be repaired and maintained, and a significant proportion of which would have to be replaced over the next decade.

[29] For reference, these future heating systems costs are about 1.2% of what Ireland's Gross National Product is projected to be in 2030 (DECC, 2020).



High levels of renewable energy supply and decarbonisation of heat do not necessarily lead to significant increase in costs to meet our heating requirements – the additional cost of capital investment is more than balanced by the savings in energy expenditure.

Figure 11: Annual whole system costs across scenarios.

Table 5: Breakdown of annual whole-system costs per scenario, including energy expenditure, CAPEX and OPEX.

		2030 Scenarios		
Whole Heat Supply System Cost	2018 Baseline (€bn/yr)	NECP_WAM (€bn/yr)	RES-H_7% (€bn/yr)	RES-H_Max (€bn/yr)
Oil	1.165	0.778	0.444	0.292
Gas	0.935	0.884	0.718	0.411
Coal	0.050	0.033	0.024	–
Peat	0.154	0.054	–	–
Wastes (Non-Renewable)	0.011	0.078	0.087	0.087
Surplus Heat	–	–	0.056	0.162
Biomass	0.159	0.263	0.630	0.641
RES-gas mix	–	0.073	0.172	0.457
Solar	–	–	–	–
Ambient energy	–	–	–	–
Total fossil fuels	*2.315*	*1.825*	*1.272*	*0.790*
Direct elec	*0.487*	*0.371*	*0.386*	*0.291*
Heat pump elec	*0.045*	*0.421*	*0.485*	*0.544*
Renewables total	*0.159*	*0.336*	*0.858*	*1.260*
Total energy expenditure	*3.006*	*2.954*	*3.002*	*2.886*
Annualised CAPEX		*0.616*	*0.753*	*0.926*
O&M		*0.099*	*0.162*	*0.219*
Total annual energy system cost	**3.006**	**3.669**	**3.917**	**4.031**

This is borne by the levelized cost of the heat supplied calculation[30] (Figure 12) which indicates that the unit cost of the heat delivered to the consumer varies between €71.5/MWh for NECP_WAM, €76.4/MWh (+7%) for RES-H_7%, and €78.7/MWh for RES-H_Max (+10%).

From the point of view of CO_2 emission reduction, the marginal cost of further decarbonising the national heat supply between the NECP_WAM and the RES-H_7% scenario is €86/tCO_2, and €66/tCO_2 with RES-H_Max (see Figure 13). The lower marginal cost of CO_2 reductions with the RES-H_Max scenario can be explained by a combination of economies of scale as the renewable heat sector becomes the dominant player in the national heat supply, as well as the significant reliance on low-cost surplus heat with district heating in high heat density areas.

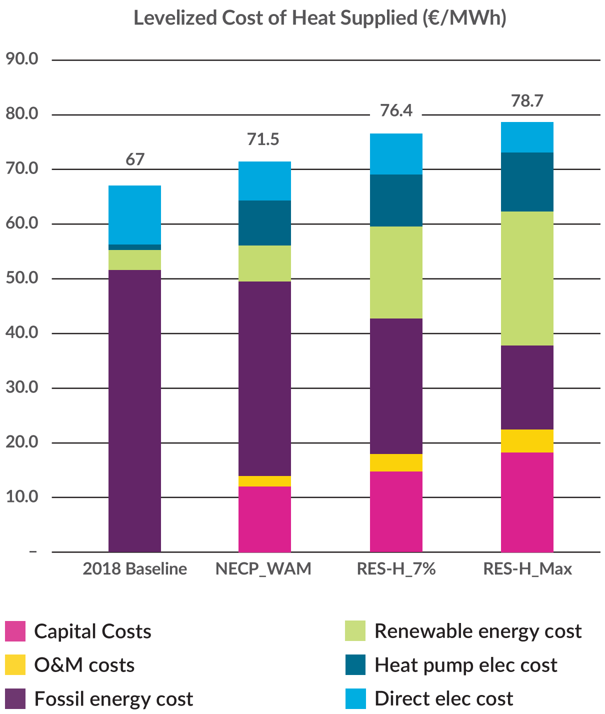


Figure 12: Levelized cost of the heat supplied.

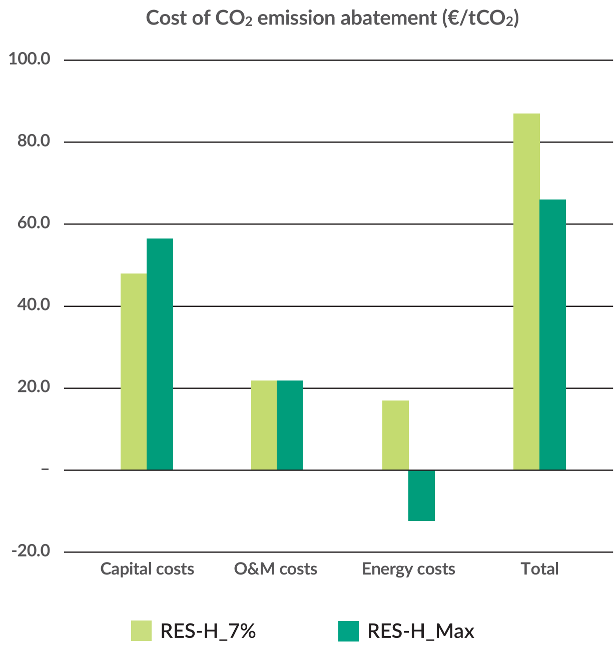


Figure 13: Cost of CO_2 emission abatement, with breakdown between capital, O&M and energy costs.

The capital investment in new RES-H systems has been estimated at €9.6 billion for the RES-H_7% scenario and €12.5 billion for the RES-H_Max scenario, including €0.7 and €3.1 billion in district heating infrastructure respectively (Table 6). That is a 25% and 60% increase on the capital investment associated with the National Energy & Climate Plan's WAM scenario (Figure 14).

[30] Annualised capital cost + other annual costs, divided by the total heating requirement.

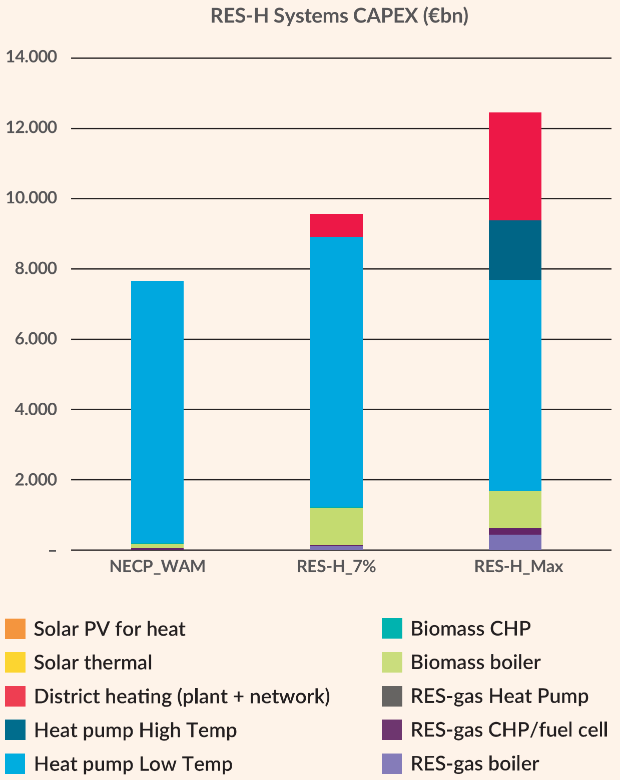


Figure 14: Breakdown of RES-H system Capex per scenario.

The capital investment required to achieve 40% of the national heat supply from renewable sources and 7% annual reduction in CO_2 emissions is about a third of the €30 billion investment earmarked for the national energy retrofit programme.

Table 6: Capital expenditure per RES-H system across scenarios.

RES-H Systems CAPEX	NECP_WAM (€bn)	RES-H_7% (€bn)	RES-H_Max (€bn)
RES-gas boiler	0.049	0.120	0.426
Biomass boiler	0.122	1.055	1.055
Biomass CHP	0.028	0.028	0.028
Heat pump Low Temp	7.476	7.688	5.985
Heat pump High Temp	–	–	1.702
Solar thermal	–	–	–
Solar PV for heat	–	–	–
RES-gas Heat Pump	–	–	–
RES-gas CHP/fuel cell	–	0.015	0.193
District heating (plant + network)	–	0.654	3.067
TOTAL	7.676	9.561	12.458

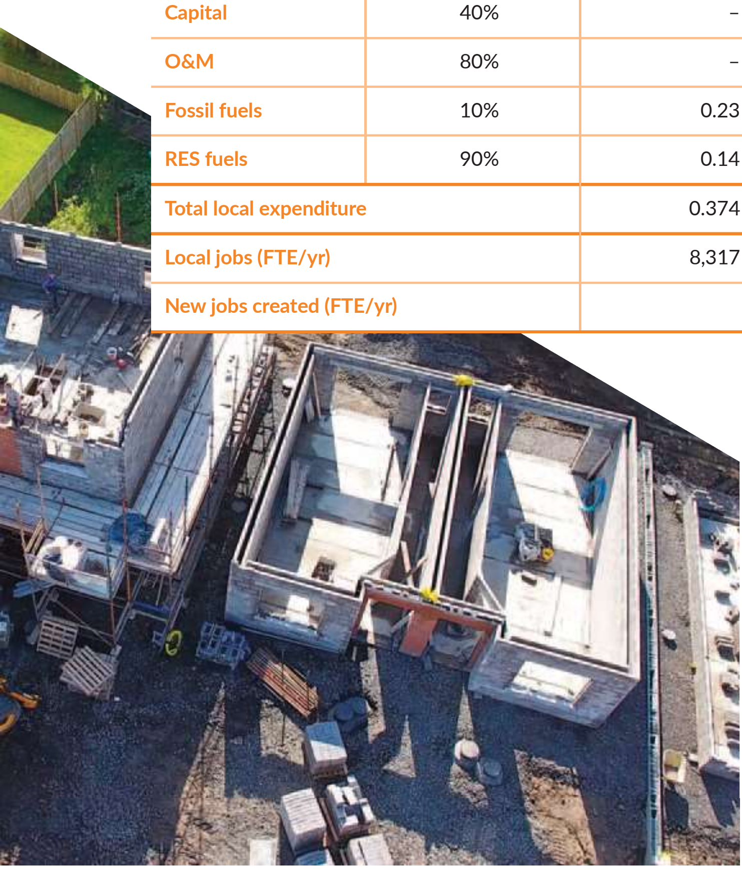
4.4 Job Creation

While it is difficult to be exact when calculating the impact of renewable heat deployment in terms of job creation, an estimate has been made here following the methodology applied in the peer-reviewed analysis behind Green Plan Ireland (Connolly & Vad Mathiesen, 2014). The methodology assumes that the average Irish employee earns €45,000/year and that the job creations associated with a given 2030 RES-H scenario is distributed equally over this decade[31] and benchmarked against the 2018 baseline. It is also assumed that the import share for investments, O&M, fossil fuels and biomass is 60%, 20%, 90%, and 10% respectively. Ideally each technology would have a specific import share but due to the nascent status of many low-carbon heating technologies in Ireland, these are currently not available and even if they were, would not be reflective of what is likely to occur as they become prominent features of the Irish heat sector.

This simplified methodology indicates that over 23,000 new jobs would be created in full-time equivalent (FTE) as an outcome of achieving the 40% renewable heat target for 2030.

Table 7: Job creation potential of renewable heat deployment.

Job creation potential		2018 Baseline (€bn/yr)	2030 Scenarios NECP_WAM (€bn/yr)	2030 Scenarios RES-H_7% (€bn/yr)	2030 Scenarios RES-H_Max (€bn/yr)
Cost item	Spent locally				
Capital	40%	–	0.307	0.382	0.498
O&M	80%	–	0.079	0.129	0.175
Fossil fuels	10%	0.23	0.18	0.13	0.08
RES fuels	90%	0.14	0.30	0.77	1.13
Total local expenditure		0.374	0.872	1.412	1.887
Local jobs (FTE/yr)		8,317	19,371	31,372	41,931
New jobs created (FTE/yr)			**11,053**	**23,055**	**33,614**



Achieving the 40% renewable heat target of scenario RES-H by 2030 would result in the creation of over 23,000 new jobs over this decade.

[31] Capital expenditure, O&M costs and energy costs calculated have been averaged over a 10 year period.

5

A Call to Action

Overall, this analysis provides evidence that Ireland can and should adopt an ambitious 40% renewable heat target, that will put our nation on the right path to achieve zero-carbon heating by 2050. This can be achieved cost-effectively with the country's natural renewable energy resources, benefiting Ireland's balance of payment by a €1 billion saving in imported fossil fuels compared to 2018.

Achieving this ambitious 40% target by 2030 means growing the production of renewable heat by an absolute 3.4% every year from the current 6% share. This will require a radical market transformation, underpinned by deep reform of the heating sector with technological innovation, training and education, as well as infrastructural development. This presents significant challenges for our society, but the good news is that the environmental and socio-economic dividends will be very significant. Capital investment in green technologies, together with their operation & maintenance, and the development of local supply chains in indigenous biomass fuels, will lead to tremendous job creation opportunities, in particular in our rural communities.

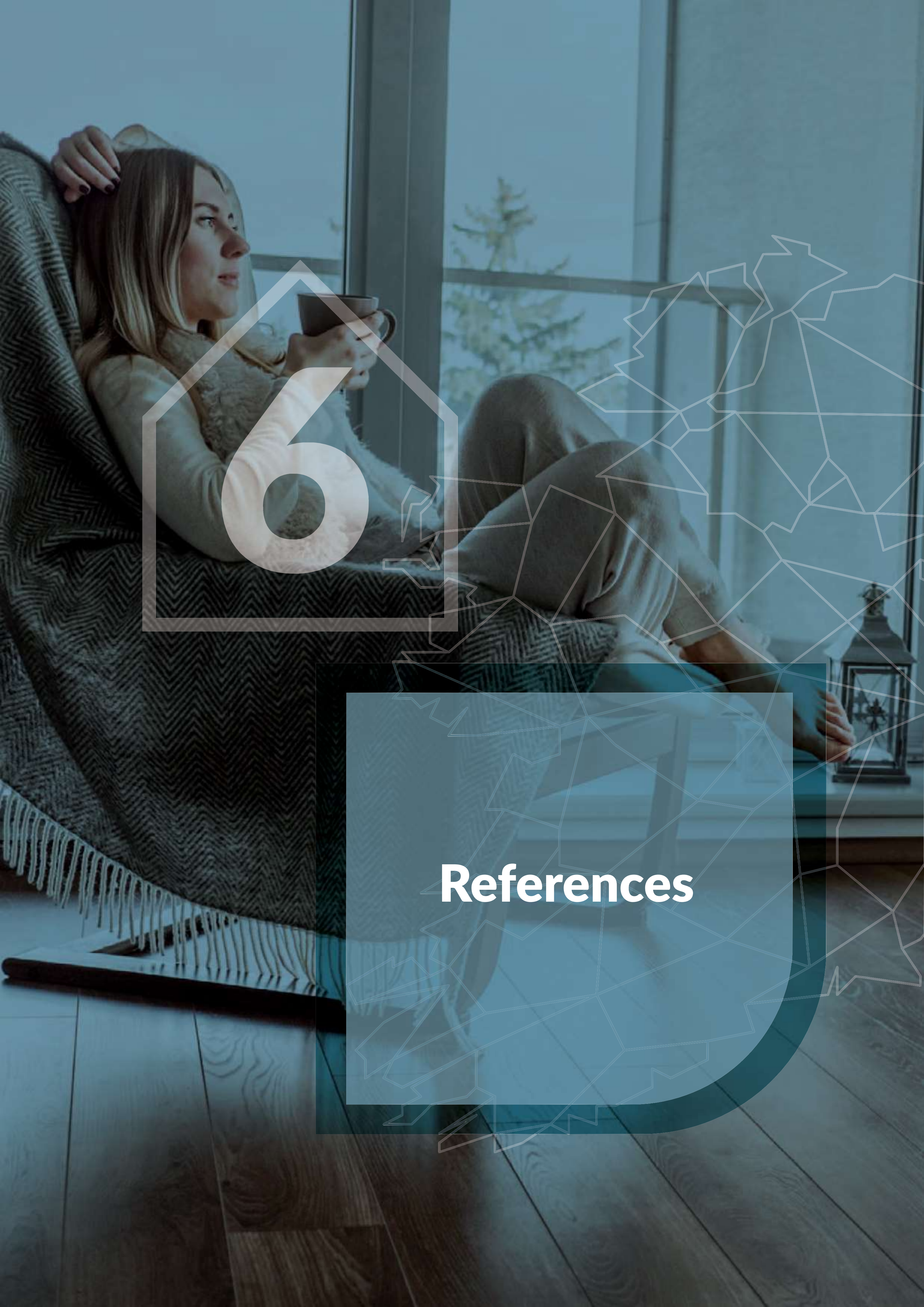
A detailed list of changes is included in this report, outlining how government and industry can work together to deliver a 40% renewable heat target by 2030. The list includes 21 actions for government across policy and regulation (7), financial stabilisation (11) and capacity building (3). It also includes 19 industry-led actions the renewable heat sector is prepared to drive if an ambitious target is put in place across capacity building (7), innovation (4), quality assurance (5) and awareness-raising (3).

Here are a number of highlights of cross-sectorial actions required:

1. Updating the building regulations and BER assessment methodology to accurately reflect the decarbonisation benefits of renewable heat.
2. Simplify administrative & regulatory requirement barriers, particularly in relation to financial incentives for renewable heat technologies to increase uptake and reduce compliance costs.
3. Implement Article 23 of the Renewable Energy Directive (REDII) under the EU Clean Energy Package with a mandatory high ambition of at least 3% per annum.
4. Set Green Procurement targets for the public sector at a minimum of a 20% annual increase in renewable heat and mandate that all new or replacement heating systems to be 100% renewable.
5. Widen the support for renewable heat in the Home Energy Grants and in the Support Scheme for Renewable Heat (SSRH), and seek ways to incentivise large heat users to adopt renewable heat solutions.

The table on the next page provides key details of cross-sectorial measures that are advocated by the members of Renewable Energy Ireland, with their aims, proposed lead and support roles, the next steps to be undertaken and target dates, and the likely impacts of not taking action. A complete list is put forward in Annex 4 of this report.

Sector	Policy Improvement	Description	Aim	Lead	Supporting Role	Next Step	Target Date	Impact of Delay on 2030 targets
Buildings	**All RES-H 1** **Building Regulations Part L**	Update Building Regulations Part L compliance procedure and BER methodology to reflect properly the decarbonisation benefit of renewable heat options.	Remove Part L compliance & BER methodology barriers to the adoption of renewable heat technologies & district heating.	DHLGH	SEAI, REI RGFI, IrBEA, IrDEA	a) Cross-sectorial working group to prepare recommendations. b) Publication of revised methodology and software update. c) Raise awareness and educate BER assessors & advisors.	a) H1 2021 b) H2 2021 c) H2 2021	Decision-makers will continue to be disincentivised to adopt cost-effective decarbonisation solutions.
Cross-sectorial	**All RES-H 2** **Simplify regulatory & administrative requirements**	Terms & conditions and procedures for funding schemes to be streamlined and simplified. Accelerate digitalisation of processes. Foster a collaborative approach between funding authorities & industry.	Remove red tape and accelerate access to financial supports by consumers.	SEAI, DECC, DHLGH (Building Regulations), DAFM.	REI RGFI, IrBEA, IrDEA	a) Co-design approach to schemes administration. b) Publish joint Quality Assurance and Consumer Protection Charter. c) Investment in efficient administrative systems. d) Annual review of progress by joint steering committee.	a) H1 2021 b) H2 2021 c) H2 2021 d) Annual	Failure to mobilise private and state investment in RE technologies and continuing dependence on fossil fuels in the heat sector.
Cross-sectorial	**All RES-H 3** **Renewable Heat Obligation Scheme**	Implement Article 23 of REDII with a mandatory high ambition of at least 3% per annum.	To mandate fuel suppliers to increase the share of RES-H in their supply by 3% per year.	DECC, Department of Transport, NORA	REI, RGFI, IrBEA, IrDEA	a) Establish administrative system (certification, M&V, etc.) b) Introduction of Renewable Heat Obligation Scheme, in line with transposition of REDII. c) Annual review in CAP by steering committee.	a) H1 2021 b) H1 2021 c) Annual	Consumer carrying financial burden on lack of choice. Anti-competitiveness, non-compliance with SDG's, ESG's.
Non-residential	**All-RES-H 4** **Public sector green procurement**	Public sector to set Green Procurement targets at a minimum of a 20% annual increase in RES-H. All new or replacement of heating systems procured to be 100% renewable.	Public sector to be driver for adoption of renewable heat through green procurement policy and practices.	DPER, all public bodies.	OGP, REI, RGFI, IrBEA, IrDEA	a) Mandate an annual increasing share of renewable heating in the Green Procurement Guidance for the Public Sector. b) Establish M&V system with annual reporting.	H2 2021	Prevent 'locked in' fossil fuels in the public sector.
Tertiary & Industry	**All RES-H5** **Non-residential sectors, incl. industry & ETS sectors**	Widen and improve supports for RES-H in the non-residential sectors. Seek ways to incentivise large users of heat to adopt RES-H, including in hard to decarbonise sectors, in particular industry and ETS sector.	Support the decarbonisation of the industrial sector and encourage efficient use of RES resources.	DECC, SEAI	REI, RGFI, IrBEA, IrDEA	a) Improve and widen SSRH supports for biomass, renewable gas, heat pump and district heating systems. b) Remove carbon tax exemption for fossil-fuel based CHP. c) Increase carbon tax. d) Detailed study of ETS and non-ETS sectors on large heat users solutions.	H2 2021	RES-H remains uncompetitive, hard to decarbonise sectors lagging behind and their economic activity being impacted.
Residential	**All RES-H6** **Wider domestic grant supports**	Expand range RES-H technologies eligible for Home Energy Grants and offer more options to homeowners, including for hard to retrofit homes.	Remove barriers to adoption and incentivise a wider range of RES-H options.	SEAI, DECC	REI, RGFI, IrBEA, IrDEA	a) Incentivise bioenergy solutions and district heating substations. b) Relax max HLI requirement for heat pumps retrofits.	Budget 2022	Much of the existing housing stock will remain on fossil fuels for the foreseeable future.



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References

Calvo Buendia E, T. K. (2019). *2019 Refinement to the IPCC Guidelines for National Greenhouse Gas Inventories.* Geneva: IPCC.

COFORD. (2018). *Wood Supply and Demand on the Island of Ireland to 2025*. COFORD Wood Mobilisation and Production Forecasting Group.

DAFM. (2020). *Forest Statistics, Ireland 2020*. Wexford: Department of Agriculture, Food and Marine.

Connolly, D., & Vad Mathiesen, B. (2014, 7 28). A technical and economic analysis of one potential pathway to 100% renewable energry system (for Ireland). *International journal of Sustainable Energy Planning and Management*, p. Vol. 01.

DECC. (2019). *Climate Action Plan*. Dublin: Department of the Environment, Climate and Communications.

DECC. (2020). *National Energy & Climate Plan 2021-2030*. Dublin: Department of Communications, Climate Action & Environment.

Dr Paul Deane, L. M. (2020, November). *Our Zero e Mission Future Report*. Retrieved from Electricity Association of Ireland: https://eaireland.com/wp-content/uploads/2020/11/Our-Zero-e-Mission-Future-Report.pdf

GAI. (2020). *Strategy for Geothermal Energy Development to 2030*. Geothermal Association of Ireland (communication to RES HPI steering committee).

IrBEA & Cre. (2019). *Biogas Suppport Scheme. Mobilising an Irish Biogas Industry with Policy and Action.*

IrDEA. (2020). *Internal review of the potential of surplus heat in Ireland by 2030, based on the Heat Roadmap Europe study.*

J. McEniry, P. C. (2013). How much grassland biomass is available in Ireland in excess of livestock requirements? *Irish Journal of Agricultural and Food Research*, *vol.52*, pp. 67–80.

Persson U, M. B. (2014/2019). Heat Roadmap Europe: Identifying strategic heat synergy region (updated with Irish Atlas study results). *Energy Policy 2014*, *vol.74*, 663-681.

Ricardo. (2016). *Bioenergy Supply in Ireland 2015 – 2035*. SEAI.

Richard O'Shea, D. M. (2017). Assessing the total theoretical, and financially viable, resource of biomethane for injection to a natural gas network in a region. *Applied Energy, 188*, pp. 237–256.

SEAI. (2013). *Methodology for Local Authority Renewable Energy Strategies*. SEAI, prepared by RPS.

SEAI. (2019). *Energy in Ireland - 2019 Report*. Dublin: Sustainable Energy Authority of Ireland.

Tobias Naegler, S. S. (2015). Quantification of the European industrial heat demand by branch and temperature level. *International Journal of Energy Research*, pp. 39:2019–2030.

Annex 1. Details of final energy consumption for the scenarios modelled

				2030 Scenarios		
Sector	Fuel	Temperature grade	2018 Baseline (TWh/yr)	NECP_WAM (TWh/yr)	RES-H_7% (TWh/yr)	RES-H_Max (TWh/yr)
Residential	Oil	All	13	5	4	2
Residential	Gas	All	7.03	5.62	3.34	–
Residential	Coal	All	1.80	0.68	–	–
Residential	Peat	All	2.29	0.78	–	–
Residential	Direct elec	All	1.56	0.60	0.60	0.60
Residential	Wastes (Non-Renewable)	All	–	–	–	–
Residential	Biomass	All	0.33	0.31	1.78	1.78
Residential	RES-gas mix	All	–	0.20	0.54	1.85
Residential	DH mix	All	–	–	1.66	4.91
Residential	Solar	All	0.15	0.16	0.16	0.16
Residential	Ambient energy	All	0.32	4.60	4.59	4.59
Residential	Heat pump elec	All	0.16	1.88	1.97	1.97
Residential	Renewables total	All	0.79	5.28	7.08	8.39
Residential	Grand total (incl all RES)	SH: Heat pump ready	7.95	12.41	12.10	11.17
Residential	Grand total (incl all RES)	SH, HW: <60°C	12.26	5.07	4.94	4.56
Residential	Grand total (incl all RES)	SH, HW: 60-100°C	6.73	2.10	2.04	1.89
Residential	Grand total (incl all RES)	PH: 100-400°C	–	–	–	–
Residential	Grand total (incl all RES)	PH: >400°C	–	–	–	–
Residential	Grand total (incl all RES)	All	26.94	19.57	19.09	17.61
Tertiary	Oil	All	3.12	2.42	–	–
Tertiary	Gas	All	6.19	4.81	4.41	1.25
Tertiary	Coal	All	–	–	–	–
Tertiary	Peat	All	–	–	–	–
Tertiary	Direct elec	All	0.60	0.60	0.60	–
Tertiary	Wastes (Non-Renewable)	All	–	–	–	–
Tertiary	Biomass	All	0.30	0.65	2.01	2.01
Tertiary	RES-gas mix	All	0.09	0.24	0.31	1.06
Tertiary	DH mix	All	–	–	1.09	3.22
Tertiary	Solar	All	–	–	–	–
Tertiary	Ambient energy	All	0.20	1.69	1.90	1.90
Tertiary	Heat pump elec	All	0.13	0.72	0.81	0.81
Tertiary	Renewables total	All	0.59	2.58	4.22	4.97
Tertiary	Grand total (incl all RES)	SH: Heat pump ready	3.13	7.06	7.06	6.50
Tertiary	Grand total (incl all RES)	SH, HW: <60°C	4.83	2.88	2.88	2.65
Tertiary	Grand total (incl all RES)	SH, HW: 60-100°C	2.66	1.19	1.19	1.10
Tertiary	Grand total (incl all RES)	PH: 100-400°C	–	–	–	–
Tertiary	Grand total (incl all RES)	PH: >400°C	–	–	–	–
Tertiary	Grand total (incl all RES)	All	10.62	11.13	11.14	10.25
Industry	Oil	All	6.00	7.82	4.10	3.88
Industry	Gas	All	9.19	10.74	9.45	8.60
Industry	Coal	All	1.22	1.30	1.43	–
Industry	Peat	All	0.01	0.02	–	–
Industry	Direct elec	All	0.95	1.16	1.26	1.26
Industry	Wastes (Non-Renewable)	All	0.64	0.78	0.87	0.87
Industry	Biomass	All	2.28	3.86	7.68	7.68
Industry	RES-gas mix	All	0.03	0.34	1.01	3.47
Industry	DH mix	All	–	–	–	–

Sector	Fuel	Temperature grade	2018 Baseline (TWh/yr)	2030 Scenarios NECP_WAM (TWh/yr)	2030 Scenarios RES-H_7% (TWh/yr)	2030 Scenarios RES-H_Max (TWh/yr)
Industry	Solar	All	–	–	–	–
Industry	Ambient energy	All	0.00	0.27	0.90	0.09
Industry	Heat pump elec	All	–	0.09	0.30	0.30
Industry	Renewables total	All	2.28	4.48	9.59	12.05
Industry	Grand total (incl all RES)	SH: Heat pump ready	–	–	–	–
Industry	Grand total (incl all RES)	SH, HW: <60°C	–	–	–	–
Industry	Grand total (incl all RES)	SH, HW: 60-100°C	6.52	8.47	8.66	8.65
Industry	Grand total (incl all RES)	PH: 100-400°C	5.18	6.73	6.88	6.87
Industry	Grand total (incl all RES)	PH: >400°C	8.62	11.19	11.45	11.43
Industry	Grand total (incl all RES)	All	20.32	26.38	27.00	26.95
Total	Oil	All	22.43	14.97	8.54	5.62
Total	Gas	All	22.40	21.17	17.20	9.85
Total	Coal	All	3.03	1.98	1.43	–
Total	Peat	All	2.30	0.80	–	–
Total	Direct elec	All	3.11	2.37	2.47	1.86
Total	Wastes (Non-Renewable)	All	0.64	0.78	0.87	0.87
Total	Biomass	All	2.93	4.83	11.47	11.47
Total	RES-gas mix	All	0.11	0.79	1.86	6.37
Total	DH mix	All	–	–	2.74	8.13
Total	Solar	All	0.16	0.16	0.16	0.16
Total	Ambient energy	All	0.51	6.56	7.40	7.40
Total	Heat pump elec	All	0.26	2.69	3.08	3.08
Total	Renewables total	All	3.72	12.34	20.89	25.40
Total	Grand total (incl all RES)	SH: Heat pump ready	11.08	19.47	19.17	17.67
Total	Grand total (incl all RES)	SH, HW: <60°C	17.09	7.95	7.82	7.21
Total	Grand total (incl all RES)	SH, HW: 60-100°C	15.91	11.75	11.90	11.63
Total	Grand total (incl all RES)	PH: 100-400°C	5.18	6.73	6.88	6.87
Total	Grand total (incl all RES)	PH: >400°C	8.62	11.19	11.45	11.43
Total	Grand total (incl all RES)	All	57.76	57.09	57.22	54.81
Total	DH mix	Meet distbn and storage loss	–	–	0.27	0.81
Total	Direct elec	CHP generated electricity	–	0.37	0.37	0.37

District heating heat by fuel

DH Component Fuel	2018 Baseline (TWh/yr)	NECP_WAM (TWh/yr)	RES-H_7% (TWh/yr)	RES-H_Max (TWh/yr)
Solid biomass		0.00	0.19	0.68
RES-gas mix		0.00	0.00	0.00
Heat pump elec		0.00	0.01	0.17
Waste heat		0.00	2.82	8.10
Solar		0.00	0.00	0.00
HP Ambient		0.00	0.00	0.00

Totals with DH assigned to individual fuels

				2030 Scenarios		
Sector	**Fuel**	**Temperature grade**	**2018 Baseline (TWh/yr)**	**NECP_WAM (TWh/yr)**	**RES-H_7% (TWh/yr)**	**RES-H_Max (TWh/yr)**
Total	Oil	All	22.43	14.97	8.54	5.62
Total	Gas	All	22.40	21.17	17.20	9.85
Total	Coal	All	3.03	1.98	1.43	-
Total	Peat	All	2.30	0.80	-	-
Total	Direct elec	All	3.11	2.37	2.47	1.86
Total	Wastes (Non-Renewable)	All	0.64	0.78	0.87	0.87
Total	Biomass	All	2.93	4.83	11.66	12.14
Total	RES-gas mix	All	0.11	0.79	1.86	6.37
Total	Surplus/Geothermal	All	–	–	2.82	8.10
Total	Solar	All	0.16	0.16	0.16	0.16
Total	Ambient energy	All	0.51	6.56	7.40	7.40
Total	Heat pump elec	All	0.26	2.69	3.09	3.25
Total	Total (based on deliv fuels)	All	57.20	50.37	49.94	48.06
Total	Renewables total	All	3.72	12.34	21.08	26.08
Total	Grand total (incl all RES)	SH: Heat pump ready	11.08	19.47	19.17	17.67
Total	Grand total (incl all RES)	SH, HW: <60°C	17.09	7.95	7.82	7.21
Total	Grand total (incl all RES)	SH, HW: 60-100°C	15.91	11.75	11.90	11.63
Total	Grand total (incl all RES)	PH: 100-400°C	5.18	6.73	6.88	6.87
Total	Grand total (incl all RES)	PH: > 400°C	8.62	11.19	11.45	11.43
Total	Grand total (incl all RES)	All	57.88	57.09	57.50	55.63

Annex 2. Thermal energy mix per sector and per scenarios modelled

				2030 Scenarios		
Sector	Energy Source	Temperature grade	2018 Baseline	NECP_WAM	RES-H_7%	RES-H_Max
Residential	Oil	All	49.4%	24.2%	23.3%	9.9%
Residential	Gas	All	26.1%	28.7%	17.5%	0.0%
Residential	Coal	All	6.7%	3.5%	0.0%	0.0%
Residential	Peat	All	8.5%	4.0%	0.0%	0.0%
Residential	Direct elec	All	5.8%	3.1%	3.2%	3.4%
Residential	Wastes (Non-Renewable)	All	0.0%	0.0%	0.0%	0.0%
Residential	Biomass	All	1.2%	1.6%	9.3%	10.1%
Residential	RES-gas mix	All	0.0%	1.0%	2.8%	10.5%
Residential	DH mix	All	0.0%	0.0%	8.7%	27.9%
Residential	Solar	All	0.6%	0.8%	0.9%	0.9%
Residential	Ambient energy	All	1.2%	23.5%	24.1%	26.1%
Residential	Heat pump elec	All	0.6%	9.6%	10.3%	11.2%
Residential	Renewables total	All	2.9%	27.0%	37.1%	47.6%
Residential	Grand total (incl all RES)	SH: Heat pump ready	29.5%	63.4%	63.4%	63.4%
Residential	Grand total (incl all RES)	SH, HW: <60°C	45.5%	25.9%	25.9%	25.9%
Residential	Grand total (incl all RES)	SH, HW: 60-100°C	25.0%	10.7%	10.7%	10.7%
Residential	Grand total (incl all RES)	PH: 100-400°C	0.0%	0.0%	0.0%	0.0%
Residential	Grand total (incl all RES)	PH: > 400°C	0.0%	0.0%	0.0%	0.0%
Residential	Grand total (incl all RES)	All	100.0%	100.0%	100.0%	100.0%
Tertiary	Oil	All	29.3%	21.7%	0.0%	0.0%
Tertiary	Gas	All	58.2%	43.2%	39.6%	12.2%
Tertiary	Coal	All	0.0%	0.0%	0.0%	0.0%
Tertiary	Peat	All	0.0%	0.0%	0.0%	0.0%
Tertiary	Direct elec	All	5.7%	5.4%	5.4%	0.0%
Tertiary	Wastes (Non-Renewable)	All	0.0%	0.0%	0.0%	0.0%
Tertiary	Biomass	All	2.8%	5.8%	18.0%	19.6%
Tertiary	RES-gas mix	All	0.8%	2.2%	2.8%	10.3%
Tertiary	DH mix	All	0.0%	0.0%	9.8%	31.5%
Tertiary	Solar	All	0.0%	0.0%	0.0%	0.0%
Tertiary	Ambient energy	All	1.9%	15.1%	17.1%	18.6%
Tertiary	Heat pump elec	All	1.2%	6.5%	7.3%	7.9%
Tertiary	Grand total (incl all RES)	SH: Heat pump ready	29.5%	63.4%	63.4%	63.4%
Tertiary	Grand total (incl all RES)	SH, HW: <60°C	45.5%	25.9%	25.9%	25.9%
Tertiary	Grand total (incl all RES)	SH, HW: 60-100°C	25.0%	10.7%	10.7%	10.7%
Tertiary	Grand total (incl all RES)	PH: 100-400°C	0.0%	0.0%	0.0%	0.0%
Tertiary	Grand total (incl all RES)	PH: > 400°C	0.0%	0.0%	0.0%	0.0%
Tertiary	Grand total (incl all RES)	All	100.0%	100.0%	100.0%	100.0%
Industry	Oil	All	29.5%	29.6%	15.2%	14.4%
Industry	Gas	All	45.2%	40.7%	35.0%	31.9%
Industry	Coal	All	6.0%	4.9%	5.3%	0.0%
Industry	Peat	All	0.1%	0.1%	0.0%	0.0%
Industry	Direct elec	All	4.7%	4.4%	4.7%	4.7%
Industry	Wastes (Non-Renewable)	All	3.1%	2.9%	3.2%	3.2%
Industry	Biomass	All	11.2%	14.6%	28.4%	28.5%
Industry	RES-gas mix	All	0.1%	1.3%	3.7%	12.9%
Industry	DH mix	All	0.0%	0.0%	0.0%	0.0%
Industry	Solar	All	0.0%	0.0%	0.0%	0.0%

				2030 Scenarios		
Sector	Energy Source	Temperature grade	2018 Baseline	NECP_WAM	RES-H_7%	RES-H_Max
Industry	Ambient energy	All	0.0%	1.0%	3.3%	3.3%
Industry	Heat pump elec	All	0.0%	0.3%	1.1%	1.1%
Industry	Grand total (incl all RES)	SH: Heat pump ready	0.0%	0.0%	0.0%	0.0%
Industry	Grand total (incl all RES)	SH, HW: <60°C	0.0%	0.0%	0.0%	0.0%
Industry	Grand total (incl all RES)	SH, HW: 60-100°C	32.1%	32.1%	32.1%	32.1%
Industry	Grand total (incl all RES)	PH: 100-400°C	25.5%	25.5%	25.5%	25.5%
Industry	Grand total (incl all RES)	PH: > 400°C	42.4%	42.4%	42.4%	42.4%
Industry	Grand total (incl all RES)	All	100.0%	100.0%	100.0%	100.0%
Total	Oil	All	38.8%	26.2%	14.9%	10.3%
Total	Gas	All	38.8%	37.1%	30.1%	18.0%
Total	Coal	All	5.2%	3.5%	2.5%	0.0%
Total	Peat	All	4.0%	1.4%	0.0%	0.0%
Total	Direct elec	All	5.4%	4.2%	4.3%	3.4%
Total	Wastes (Non-Renewable)	All	1.1%	1.4%	1.5%	1.6%
Total	Biomass	All	5.1%	8.5%	20.0%	20.9%
Total	RES-gas mix	All	0.2%	1.4%	3.3%	11.6%
Total	DH mix	All	0.0%	0.0%	4.8%	14.8%
Total	Solar	All	0.3%	0.3%	0.3%	0.3%
Total	Ambient energy	All	0.9%	11.5%	12.9%	13.5%
Total	Heat pump elec	All	0.4%	4.7%	5.4%	5.6%
Total	Grand total (incl all RES)	SH: Heat pump ready	19.2%	34.1%	33.5%	32.2%
Total	Grand total (incl all RES)	SH, HW: <60°C	29.6%	13.9%	13.7%	13.2%
Total	Grand total (incl all RES)	SH, HW: 60-100°C	27.5%	20.6%	20.8%	21.2%
Total	Grand total (incl all RES)	PH: 100-400°C	9.0%	11.8%	12.0%	12.5%
Total	Grand total (incl all RES)	PH: > 400°C	14.9%	19.6%	20.0%	20.9%
Total	Grand total (incl all RES)	All	100.0%	100.0%	100.0%	100.0%

Total with heat supplied by district heating broken down per heat source

				2030 Scenarios		
Sector	Energy Source	Temperature grade	2018 Baseline	NECP_WAM	RES-H_7%	RES-H_Max
Total	Oil	All	38.7%	26.2%	14.8%	10.1%
Total	Gas	All	38.7%	37.1%	29.9%	17.7%
Total	Coal	All	5.2%	3.5%	2.5%	0.0%
Total	Peat	All	4.0%	1.4%	0.0%	0.0%
Total	Direct elec	All	5.4%	4.2%	4.3%	3.3%
Total	Wastes (Non-Renewable)	All	1.1%	1.4%	1.5%	1.6%
Total	Biomass	All	5.1%	8.5%	20.3%	21.8%
Total	RES-gas mix	All	0.2%	1.4%	3.2%	11.5%
Total	Surplus Heat/Geothermal	All	0.0%	0.0%	4.9%	14.6%
Total	Solar	All	0.3%	0.3%	0.3%	0.3%
Total	Ambient energy	All	0.9%	11.5%	12.9%	13.3%
Total	Heat pump elec	All	0.4%	4.7%	5.4%	5.8%
Total	Renewables total	All	6.4%	21.6%	36.7%	46.9%
Total	Grand total (incl all RES)	SH: Heat pump ready	19.1%	34.1%	33.3%	31.8%
Total	Grand total (incl all RES)	SH, HW: <60°C	29.5%	13.9%	13.6%	13.0%
Total	Grand total (incl all RES)	SH, HW: 60-100°C	27.5%	20.6%	20.7%	20.9%
Total	Grand total (incl all RES)	PH: 100-400°C	9.0%	11.8%	12.0%	12.4%
Total	Grand total (incl all RES)	PH: > 400°C	14.9%	19.6%	19.9%	20.5%
Total	Grand total (incl all RES)	All	100.0%	100.0%	100.0%	100.0%

Annex 3. Share of energy sources in meeting the heating requirement of each sector, per scenarios modelled

				2030 Scenarios		
Sector	Energy Source	Temperature grade	2018 Baseline	NECP_WAM	RES-H_7%	RES-H_Max
Residential	Oil	All	52.3%	23.7%	22.3%	8.8%
Residential	Gas	All	27.6%	28.2%	16.8%	0.0%
Residential	Coal	All	3.5%	2.6%	0.0%	0.0%
Residential	Peat	All	4.5%	2.8%	0.0%	0.0%
Residential	Direct elec	All	7.7%	3.4%	3.4%	3.4%
Residential	Wastes (Non-Renewable)	All	0.0%	0.0%	0.0%	0.0%
Residential	Biomass	All	1.2%	1.4%	7.7%	7.7%
Residential	RES-gas mix	All	0.0%	1.0%	2.7%	9.3%
Residential	DH mix	All	0.0%	0.0%	9.5%	33.2%
Residential	Solar	All	0.7%	0.9%	0.9%	0.9%
Residential	Ambient energy	All	1.6%	25.6%	25.7%	25.7%
Residential	Heat pump elec	All	0.8%	10.4%	11.0%	11.0%
Residential	Renewables total	All	3.5%	28.9%	37.0%	43.6%
Residential	Grand total (incl all RES)	SH: Heat pump ready	29.5%	63.4%	63.4%	63.4%
Residential	Grand total (incl all RES)	SH, HW: <60°C	45.5%	25.9%	25.9%	25.9%
Residential	Grand total (incl all RES)	SH, HW: 60-100°C	25.0%	10.7%	10.7%	10.7%
Residential	Grand total (incl all RES)	PH: 100-400°C	0.0%	0.0%	0.0%	0.0%
Residential	Grand total (incl all RES)	PH: > 400°C	0.0%	0.0%	0.0%	0.0%
Residential	Grand total (incl all RES)	All	100.0%	100.0%	100.0%	100.0%
Tertiary	Oil	All	28.7%	21.2%	0.0%	0.0%
Tertiary	Gas	All	57.0%	42.2%	38.7%	11.0%
Tertiary	Coal	All	0.0%	0.0%	0.0%	0.0%
Tertiary	Peat	All	0.0%	0.0%	0.0%	0.0%
Tertiary	Direct elec	All	7.0%	5.9%	5.9%	0.0%
Tertiary	Wastes (Non-Renewable)	All	0.0%	0.0%	0.0%	0.0%
Tertiary	Biomass	All	2.7%	5.1%	15.2%	15.2%
Tertiary	RES-gas mix	All	0.8%	2.1%	2.8%	9.3%
Tertiary	DH mix	All	0.0%	0.0%	10.9%	38.1%
Tertiary	Solar	All	0.0%	0.0%	0.0%	0.0%
Tertiary	Ambient energy	All	2.3%	16.4%	18.6%	18.6%
Tertiary	Heat pump elec	All	1.5%	7.1%	7.9%	7.9%
Tertiary	Renewables total	All	5.8%	23.7%	36.5%	43.1%
Tertiary	Grand total (incl all RES)	SH: Heat pump ready	29.5%	63.4%	63.4%	63.4%
Tertiary	Grand total (incl all RES)	SH, HW: <60°C	45.5%	25.9%	25.9%	25.9%
Tertiary	Grand total (incl all RES)	SH, HW: 60-100°C	25.0%	10.7%	10.7%	10.7%
Tertiary	Grand total (incl all RES)	PH: 100-400°C	0.0%	0.0%	0.0%	0.0%
Tertiary	Grand total (incl all RES)	PH: > 400°C	0.0%	0.0%	0.0%	0.0%
Tertiary	Grand total (incl all RES)	All	100.0%	100.0%	100.0%	100.0%
Industry	Oil	All	30.3%	30.5%	16.0%	15.1%
Industry	Gas	All	46.3%	41.8%	36.8%	33.5%
Industry	Coal	All	3.1%	3.9%	4.3%	0.0%
Industry	Peat	All	0.0%	0.1%	0.0%	0.0%
Industry	Direct elec	All	6.0%	5.0%	5.4%	5.4%
Industry	Wastes (Non-Renewable)	All	3.0%	2.5%	2.8%	2.8%
Industry	Biomass	All	11.1%	13.4%	25.9%	25.9%

				2030 Scenarios		
Sector	Energy Source	Temperature grade	2018 Baseline	NECP_WAM	RES-H_7%	RES-H_Max
Industry	RES-gas mix	All	0.1%	1.2%	3.5%	12.0%
Industry	DH mix	All	0.0%	0.0%	0.0%	0.0%
Industry	Solar	All	0.0%	0.0%	0.0%	0.0%
Industry	Ambient energy	All	0.0%	1.2%	3.9%	3.9%
Industry	Heat pump elec	All	0.0%	0.4%	1.3%	1.3%
Industry	Renewables total	All	11.1%	15.8%	33.3%	41.8%
Industry	Grand total (incl all RES)	SH: Heat pump ready	0.0%	0.0%	0.0%	0.0%
Industry	Grand total (incl all RES)	SH, HW: <60°C	0.0%	0.0%	0.0%	0.0%
Industry	Grand total (incl all RES)	SH, HW: 60-100°C	32.1%	32.1%	32.1%	32.1%
Industry	Grand total (incl all RES)	PH: 100-400°C	25.5%	25.5%	25.5%	25.5%
Industry	Grand total (incl all RES)	PH: > 400°C	42.4%	42.4%	42.4%	42.4%
Industry	Grand total (incl all RES)	All	100.0%	100.0%	100.0%	100.0%
Total	Oil	All	40.0%	26.2%	15.0%	9.9%
Total	Gas	All	39.9%	37.1%	30.2%	17.3%
Total	Coal	All	2.7%	2.7%	2.0%	0.0%
Total	Peat	All	2.0%	1.0%	0.0%	0.0%
Total	Direct elec	All	6.9%	4.6%	4.8%	3.6%
Total	Wastes (Non-Renewable)	All	1.1%	1.1%	1.3%	1.3%
Total	Biomass	All	5.0%	7.5%	17.4%	17.4%
Total	RES-gas mix	All	0.2%	1.3%	3.1%	10.5%
Total	DH mix	All	0.0%	0.0%	5.5%	19.2%
Total	Solar	All	0.3%	0.3%	0.3%	0.3%
Total	Ambient energy	All	1.1%	12.8%	14.4%	14.4%
Total	Heat pump elec	All	0.6%	5.2%	6.0%	6.0%
Total	Renewables total	All	6.7%	21.9%	35.3%	42.7%
Total	Grand total (incl all RES)	SH: Heat pump ready	19.1%	34.9%	34.8%	34.8%
Total	Grand total (incl all RES)	SH, HW: <60°C	29.4%	14.2%	14.2%	14.2%
Total	Grand total (incl all RES)	SH, HW: 60-100°C	27.5%	20.3%	20.3%	20.3%
Total	Grand total (incl all RES)	PH: 100-400°C	9.0%	11.5%	11.5%	11.5%
Total	Grand total (incl all RES)	PH: > 400°C	15.0%	19.1%	19.1%	19.1%
Total	Grand total (incl all RES)	All	100.0%	100.0%	100.0%	100.0%

Total with heat supplied by district heating broken down per heat source

				2030 Scenarios		
Sector	Energy Source	Temperature grade	2018 Baseline	NECP_WAM	RES-H_7%	RES-H_Max
Total	Oil	All	40.0%	26.2%	14.9%	9.7%
Total	Gas	All	39.9%	37.1%	30.0%	17.0%
Total	Coal	All	2.7%	2.7%	1.9%	0.0%
Total	Peat	All	2.0%	1.0%	0.0%	0.0%
Total	Direct elec	All	6.9%	4.6%	4.8%	3.6%
Total	Wastes (Non-Renewable)	All	1.1%	1.1%	1.3%	1.3%
Total	Biomass	All	5.0%	7.5%	17.6%	18.1%
Total	RES-gas mix	All	0.2%	1.3%	3.1%	10.3%
Total	Waste Heat	All	0.0%	0.0%	5.6%	18.4%
Total	Solar	All	0.3%	0.3%	0.3%	0.3%
Total	Ambient energy	All	1.1%	12.8%	14.4%	14.2%
Total	Heat pump elec	All	0.6%	5.2%	6.1%	7.2%
Total	Renewables total	All	6.7%	21.9%	35.1%	41.9%
Total	Grand total (incl all RES)	SH: Heat pump ready	19.1%	34.9%	34.6%	34.2%
Total	Grand total (incl all RES)	SH, HW: <60°C	29.4%	14.2%	14.1%	14.0%
Total	Grand total (incl all RES)	SH, HW: 60-100°C	27.5%	20.3%	20.2%	20.0%
Total	Grand total (incl all RES)	PH: 100-400°C	9.0%	11.5%	11.4%	11.3%
Total	Grand total (incl all RES)	PH: > 400°C	15.0%	19.1%	19.0%	18.7%
Total	Grand total (incl all RES)	All	100.0%	100.0%	100.0%	100.0%

Annex 4. Modelling assumptions for the techno-economic analysis of renewable heat scenarios

Table 8: Technical and financial assumptions for renewable heat system modelling.

Sector	System type	System fuel	Temperature grade	Lifetime (years)	Annuity Factor	Avg heat output (i.e. system size) [kW]	Seasonal thermal efficiency [%]	Load Factor	Avg heat output [MWh/yr]	Capex/ kW [€]	O&M costs/ kW/yr [€] (excl. fuel costs)
Residential	RES-gas boiler	RES-gas mix	All	20	8.0%	10	90%	12%	11	210	20.0
Residential	Biomass boiler	Biomass	All	20	8.0%	15	80%	12%	16	500	30.0
Residential	Heat pump	Heat pump elec	SH: Heat pump ready	20	8.0%	10	350%	12%	11	1250	15.0
Residential	Heat pump	Heat pump elec	SH, HW: <60°C	20	8.0%	10	300%	12%	11	1250	15.0
Residential	Solar thermal	Solar	SH, HW: <60°C	20	8.0%	3.5	100%	6%	2	1200	8.0
Residential	Solar PV for heat	Solar	SH, HW: <60°C	25	7.1%	1.75	100%	6%	1	1700	8.0
Residential	RES-gas Heat Pump	RES-gas mix	SH, HW: <60°C	20	8.0%	10	140%	12%	11	1500	17.0
Residential	RES-gas CHP/ fuel cell	RES-gas mix	All	20	8.0%	10	50%	12%	11	875	62.5
Residential	District heating	DH mix	All	50	5.5%	10	98%	23%	20	475	15.0
Tertiary	RES-gas boiler	RES-gas mix	All	20	8.0%	300	90%	20%	526	130	10.0
Tertiary	Biomass boiler	Biomass	All	20	8.0%	300	80%	35%	920	600	15.0
Tertiary	Biomass CHP	Biomass	All	20	8.0%	300	45%	35%	920	1563	33.9
Tertiary	Heat pump	Heat pump elec	SH: Heat pump ready	20	8.0%	300	350%	35%	920	479	8.0
Tertiary	Heat pump	Heat pump elec	SH, HW: <60°C	20	8.0%	300	300%	35%	920	1100	8.0
Tertiary	Solar thermal	Solar	SH, HW: <60°C	25	7.1%	150	100%	6%	79	1500	8.0
Tertiary	Solar PV for heat	Solar	SH, HW: <60°C	20	8.0%	50	100%	6%	26	430	5.0
Tertiary	RES-gas Heat Pump	RES-gas mix	SH, HW: <60°C	20	8.0%	300	140%	35%	920	700	50.0
Tertiary	RES-gas CHP/fuel cell	RES-gas mix	All	20	8.0%	300	50%	35%	920	563	31.3
Tertiary	District heating	DH mix	All	50	5.5%	300	98%	23%	600	333	10.5
Industry	RES-gas boiler	RES-gas mix	All	20	8.0%	10000	80%	80%	70,080	75	5.0
Industry	Biomass boiler	Biomass	All	20	8.0%	10000	80%	82%	71,832	470	10.0
Industry	Biomass CHP	Biomass	All	20	8.0%	10000	45%	82%	71,832	885	26.0
Industry	Heat pump	Heat pump elec	SH, HW: <100°C	20	8.0%	1000	400%	82%	7,183	479	5.0
Industry	Heat pump	Heat pump elec	SH, HW: <100°C	20	8.0%	1000	250%	82%	7,183	839	5.0
Industry	Solar thermal	Solar	SH, HW: <100°C	25	7.1%	500	100%	6%	263	1100	3.0
Industry	Solar PV for heat	Solar	SH, HW: <100°C	20	8.0%	50	100%	82%	359	430	5.0
Industry	RES-gas Heat Pump	RES-gas mix	All	20	8.0%	1000	140%	82%	7,183	500	25.0
Industry	RES-gas CHP/fuel cell	RES-gas mix	All	20	8.0%	1000	50%	82%	7,183	500	15.6
Industry	District heating	DH mix	All	50	5.5%	10000	n/a (per scenario)	82%	71,832	238	7.5

Please note the costs for district heating refer to the heat consumer connection to the district heating network (Heat Interface Unit and connection branch).

Table 9: Capital and O&M costs for district heating network (distribution). Source: Danish Energy Agency, 2020.

Capital cost	(€/MWh delivered)
Urban	150
Suburban	655
Rural	720
Operation and maintenance	(€/MWh delivered)
O&M	1.88

Table 10: District heating plant – technical and financial assumptions for the heat producing technologies modelling.

DH component type	DH component fuel	Seasonal thermal efficiency [%]	Capex/kW [€]	O&M costs/kW/yr [€] (not including fuel costs)	Fuel cost €/kWh	Primary energy factor	CO_2 kg/kWh	Load factor per system
Biomass boiler	Solid biomass	80%	470	10.00	0.024	1.1	0.000	82%
Biomass CHP	Solid biomass	45%	885	26.04	0.024	1.1	0.000	82%
RES gas boiler	RES-gas mix	85%	75	5.00	See RES-Gas mix	See RES-Gas mix	See RES-Gas mix	23%
RES gas CHP	RES-gas mix	50%	500	15.63	See RES-Gas mix	See RES-Gas mix	See RES-Gas mix	82%
HP ambient & shallow geo	Heat pump elec	250%	479	5.00	0.092	0.647	0.166	82%
Surplus heat low temp + HP	Heat pump elec	400%	839	3.00	0.092	0.647	0.166	82%
Surplus heat high temp	Waste Heat	100%	0	1.50	0.02	1.05	0.018	82%
Solar thermal	Solar	100%	1100	3.00	0	0	0	6%
Deep Geothermal	Geothermal	100%	2000	5	0	1.1	0	82%

Table 11: Technical and financial assumptions for the production of the different renewable gas types in the mix modelled.

RES gas type	LCOE per RES GAS type (€/kWh) RES-H_7% scenario (IrBEA & Cré assumptions*)	LCOE per RES GAS type, RGFI (€/kWh) RES-H_Max (RGFI assumptions**)	Primary energy factor per RES GAS type (kWh/kWh)	CO_2 per RES GAS type [kg/kWh]
10 GWh/yr AD plant	€ 0.120		1.1	0
BioLPG	€ 0.070	€ 0.054	1.1	0.01
20 GWh/yr AD plant	€ 0.110	€ 0.085	1.1	0
40 GWh/yr AD plant	€ 0.100	€ 0.078	1.1	0

** IrBEA & Cré assumptions are based on IrBEA & Cre. (2019). Biogas support scheme. Mobilising an Irish Biogas industry with policy and action.*
*** RGFI assumptions are based on KPMG. (2019). Integrated Business Case for Biomethane in Ireland - Executive Summary. RGFI.*

Table 12: Gas network – transmission and distribution costs per unit of gas delivered.

	(€/kWh supplied)
Residential market	€ 0.0277
Tertiary & industry	€ 0.0109

Annex 5. Policy improvements and industry-led actions to support 40% renewable heat target in Ireland by 2030

Summary of Policy Improvements (PIs)

Planning & Regulatory Framework

Sector	Policy Improvement	Description	Aim	Lead	Supporting Role	Next Step	Target Date	Impact of delay on achieving 2030 targets
Cross-sectorial	**DH1** **Zone for DH with mandated connections over time**	Publish heat planning and DH zoning at local authority level to mandate deployment of DH in areas with heat density > 120 TJ/km2 and renewable heat sources, including deep geothermal, are available. Planning regulations to mandate connection to DH networks where in place, for all new developments and major redevelopments, or upon boiler replacement.	County/City Development Plans to zone for district heating networks and renewable heating deployment as a priority.	DHLGH Regional Assemblies	DH Delivery Company (see DH5), Local Authorities, Energy Agencies, IrDEA, DHGLG, DECC	a. National Planning Framework and National Development Plan to introduce planning policy that will support heat planning and DH roll-out. b. Regional Spatial & Economic Strategy to formally recommend heat planning and designation of low-carbon heat zones in County & City Development Plans. c. Guidelines for heat planning and district heating development to be issued to Regional Assemblies & Local Authorities.	a. H1 2021 b. H2 2021 c. H1 2022	Zoning is required in order to de-risk the market, and delays will significantly impact roll-out targets to 2030.
Residential and non-residential	**All RES-H1** **Building Regulations Part L**	Update Building Regulations Part L compliance procedure and BER methodology to reflect properly the decarbonisation benefit of renewable heat options such as bioenergy, surplus heat and district heating.	Remove Part L compliance & BER methodology barriers to the adoption of renewable heat technologies & district heating.	DHLGH	SEAI, REI, RGFI, IrBEA, IrDEA	a. Cross-sectorial working group to prepare recommendations for BER methodology revisions & update to associated software. b. Publication of revised methodology and software update. c. Raise awareness and educate BER assessors & technical advisors.	a. H1 2021 b. H2 2021 c. H2 2021	Decision-makers will continue to be disincentivised to adopt cost-effective decarbonisation solutions.
Cross-sectorial	**All RES-H2** **Simplify regulatory & administrative requirements**	Terms & conditions and procedures associated with application and payment of financial supports for renewable heat technologies to be streamlined and simplified with a customer-centric policy. Accelerate digitalisation of processes to increase productivity and reduce compliance burden. Foster a collaborative approach between funding authorities & industry in design and implementation of quality assurance & consumer protection policy.	Remove red tape and accelerate access to financial supports by consumers.	SEAI, DECC, DHLGH (Building Regulations), DAFM	REI, RGFI, IrBEA, IrDEA	a. All parties to engage in meaningful consultation and co-design of financial support schemes' administrative requirements & procedures. b. Publish joint Quality Assurance and Consumer Protection Charter defining principles, commitments and implementation plan. c. Investment in development and management of efficient administrative systems. d. Annual review of progress by steering committee representing stakeholders.	a. H1 2021 b. H2 2021 c. H2 2021 d. Annual	Failure to mobilise private and state investment in RE technologies and continuing dependence on fossil fuels in the heat sector.
Cross-sectorial	**All RES-H3** **Renewable Heat Obligation Scheme**	Implement Article 23 of REDII with a mandatory high ambition of at least 3% per annum. Mandated incorporation schemes have proven to be both cost efficient and effective in achieving the objective.	To mandate fuel suppliers to increase the share of RES-H in their supply by 3% per year.	DECC, Department of Transport, NORA	REI, RGFI, IrBEA, IrDEA	a. Establish administrative system for certification, M&V and quality control. b. Introduction of Renewable Heat Obligation Scheme, in line with transposition of REDII. c. Annual review in CAP by steering committee.	a. H1 2021 b. H1 2021 c. H2 2021 d. Annual	• Consumer carrying financial burden on lack of choice. • Anti-competitiveness, non-compliance with SDG's, ESG's.

Sector	Policy Improvement	Description	Aim	Lead	Supporting Role	Next Step	Target Date	Impact of delay on achieving 2030 targets
Non-residential	**All-RES-H4** **Public sector green procurement Policy for RES-H**	Public sector to lead in decarbonising its heat supply by setting Green Procurement targets at a minimum of a 20% annual increase in RES-H. All new or replacement of heating systems procured to be 100% renewable.	Public sector to be driver for adoption of renewable heat through green procurement policy and practices.	DPER, all public bodies	OGP, REI, RGFI, IrBEA, IrDEA	a. Mandate an annual increasing share of renewable heating in the Green Procurement Guidance for the Public Sector. b. Establish M&V system with annual reporting.	H2 2021	Prevent 'locked in' fossil fuels in the public sector.
Cross-sectorial	**GeoH1** **Regulatory framework & licensing**	Develop a regulatory framework for GSHPs and deep geothermal systems, including licensing and regulatory conditions for deep geothermal energy projects through a centralised government body.	Ensure the sustained development of the geothermal sector in the future.	DCCAE DHLGH	SEAI, EPA, GSI, GAI, Local Authorities	a. Develop regulatory framework for GSHPs. b. Develop regulatory framework and licensing system for deep geothermal.	a. H2 2021 b. H1 2022	Lack of consumer confidence and investor confidence results in slow development of geothermal energy.
Residential	**All RES-H5** **Mandatory boiler carbon rating & annual maintenance**	Introduce energy & carbon rating system for existing and new heating systems to foster adoption of renewable heat options at replacement. Mandate minimum carbon rating for sale of new heating appliances. Gradually raise minimal requirement towards phasing out of fossil fuel appliances. Introduce mandatory annual/bi-annual preventative maintenance scheme for heating appliances to ensure ongoing performance, emissions and safety standard.	Inform and encourage consumers to adopt renewable heating solutions at critical purchase decisions. Improve the performance of heating appliances in operation.	SEAI, DECC	REI, RGFI, IrBEA, IrDEA	a. Revise heating appliance rating system to reflect carbon performance. b. Integrate with Part L compliance requirements, subsidy schemes, RES-H Obligation Scheme, etc. c. Promote new rating system & labelling among consumers and supply chain. d. Regulate carbon rating of heating appliances being sold, raising standards to gradually phase out fossil fuel appliances.	Phase approach	Much of the older housing stock will remain on fossil fuels for the foreseeable future as the disruption and cost from deep retrofit will prove prohibitive.
Residential	**BioHEAT1** **Regulation for wood fuel quality**	Regulate wood fuel quality to improve heating efficiency and address air quality issues.	Only clean dry wood fuel is sold on the market based on the ISO 17225 standard.	DECC / SEAI	IrBEA	Regulate the moisture content of wood fuels for sale. SI 128 2016 Air Pollution Act (Marketing, Sale, Distribution and Burning of Specified Fuels (Amendment 2016)) offers an existing legislative process to implement the proposal, by extending the fuels covered to firewood, referencing ISO 17225 Part 5, Class A1 and Class A2.	Sept 2021	Wet wood fuels negatively impact on air quality and reduce heating efficiency.
Cross-sectorial	**Res-Gas1**	Recognition and inclusion of renewable gas solutions (including biomethane, BioLPG and bio-hydrogen) in Ireland's Climate Action Plan and NECP (2021-2030), for the residential, commercial, and industrial sectors, as well as transport. Align with Renewable Energy Directive definition for renewable gases. Identify opportunities and potential that will utilise and valorise this feedstock, together with the waste management sector.	To support the production and supply of RES-Gas to consumers on and off the natural gas grid. To provide investor confidence with clear direction. Develop a circular and bio economy in collaboration with the commercial waste sector.	DECC	Industry & sectoral representation, including RGFI, IrBEA, the waste management industry	a. Include the RES-Gas sector in the achievement of the 40% RES-H target, as part of Ireland's Climate Action Plan and NECP (2021-2030). b. Include a clear definition of renewable gas (incl. biomethane, BioLPG and biohydrogen current and future pathways), with default energy content and GHG emissions savings. c. Launch consultation and establish milestones. d. Define a coordinated roadmap for RES-Gas, expanding the role of the gas suppliers to decarbonise.	H2 2021	• Missing RES-H target 2030. • Economic impact of EU fines on energy consumers. • Lack of consumer choice. • Lack of clarity on renewable gas offering and exclusion of viable renewable heat technologies.

Financial Stabilisation

Sector	Policy Improvement	Description	Aim	Lead	Supporting Role	Next Step	Target Date	Impact of delay on achieving 2030 targets
Tertiary & Industry	**All RES-H6** **Non-residential sectors, incl. industry & ETS sector**	Widen and improve supports for RES-H in the non-residential sectors. Seek ways to incentivise large users of heat to adopt RES-H, including in hard to decarbonise sectors, in particular industry and ETS sector.	Support the decarbonisation of the industrial sector and encourage efficient use of RES resources.	DECC	REI, RGFI, IrBEA, IrDEA	a. SEAI to improve and widen SSRH supports (grants and tariffs), including for biomass & RES-Gas heating, biomass & RES-Gas CHP systems, heat pumps, incl. hybrid heat pumps, district heating, and solar thermal systems. b. DECC to remove carbon tax exemption for fossil-fuel based CHP. c. DECC to increase carbon tax in line with budgetary steps process towards €100/tCO_2 by 2030. d. SEAI to introduce measures to make the SSRH scheme more attractive to large industry. e. SEAI to carry out detailed study of ETS and non-ETS sectors to identify all high heat demand users and suitable measures to decarbonise heat demand.	H2 2021	RES-H remains uncompetitive with incumbent fossil fuels. Hard to decarbonise sectors lagging and their economic activity being impacted by lack of 'carbon' competitiveness.
Cross-sectorial	**HP1** **Electricity Tariffs**	Development of new dynamic time of use tariffs reflecting cost of electricity generation and carbon intensity.	Support electrification of heat, together with demand response, and renewable heating.	CRU, ESB Networks, Energy Suppliers	SEAI, HPA	a. Prioritise consumers with heat pumps for smart meter installation/ upgrade. b. Speed up the general roll out of smart meters. c. Introduce time of use tariffs for all consumers.	H2 2021	Smart grid development, with high RES-e and demand-response impeded.
Cross-sectorial	**DH2** **Heat Supply Tariff**	Surplus heat and renewable heat injected into DH network qualifies for support for the SSRH.	Incentivise harnessing surplus heat and renewable heat opportunities for supply into DH networks.	DCCAE, SEAI	CRU, IrDEA	Amend SSRH T&Cs to add surplus heat eligibility.	H2 2021	Opportunities to harness surplus heat not captured and DH remains uncompetitive
Cross-sectorial	**DH3** **Capital investment supports**	Support financing of DH network deployment with investor-specific instruments: • National DH Delivery Company (See DH5) • Local Authorities • Community cooperatives • Private developers • Heat users.	Increase viability and bankability of DH capital investment to reach 10% penetration by 2030.	DCCAE, SEAI, ERDF	Regional authorities, EC, IrDEA	a. Allocate a €650 million capital investment fund to build networks for 10% DH e.g. via the Climate Action Fund and/or a DH Price Control. b. Secure low-cost guaranteed loan facility such as the Strategic Banking Corporation of Ireland's energy efficiency scheme. c. Launch grant scheme for connection to DH network and installation of heat user interface units. For example, by offering grants equivalent to those available for heat pump and bioenergy boilers.	H2 2021	Investment in DH stalled as developers cannot finance their projects. DH remains uncompetitive against incumbents.
Cross-sectorial	**GeoH2** **Deep geothermal development fund**	Deep geothermal project development support fund for initial feasibility studies and project scoping for large scale DHN projects and commercial applications.	Reduce risk and increase investor confidence in geothermal projects.	DCCAE SEAI	DoF, DETI GAI	a. Launch 3-year fund for geothermal project development support.	H1 2022	Opportunities for viable geothermal project development not identified and no appetite for investment.

Sector	Policy Improvement	Description	Aim	Lead	Supporting Role	Next Step	Target Date	Impact of delay on achieving 2030 targets
Cross-sectorial	**RES-Gas2**	Support for industry-led projects. Empower communities to understand, participate and replicate.	Stimulate the production of scalable Agri and Waste based AD. Develop circular economy model.	DECC, DAFM & DPER	Community Power, DPER, DRCD. RGFI, IrBEA	a. Funding and supports to stimulate indigenous AD biomethane industry. b. Alignment with EGD and implementation of farm to fork and industrial waste strategies, i.e. Paris Agreement.	H2 2021	Missing RES-H targets. Consumer carrying financial burden on lack of choice. Anti-competitiveness, non-compliance with SDG's, ESG's.
Cross-sectorial	**RES-Gas3**	Provide incentives to produce and valorise BioLPG from indigenous biomass feedstocks.	Develop circular economy solutions.	DECC	DAFM, RGFI, IrBEA	a. Expand the terms of reference for the Climate Action Fund to consider BioLPG and facilitate future research & development funding for the sector. b. Renewable and low-carbon fuel producers should be incentivised to capture BioLPG or directly produce it.	a. H2 2021 b. H2 2022	Opportunity to switch consumers using higher carbon fuels like oil and solid fuels to cleaner and lower carbon solutions will be missed.
Residential	**All RES-H7** **Wider domestic grant supports**	Expand range RES-H technologies eligible for Home Energy Grants and offer more options to homeowners, including for hard to retrofit homes.	Remove barriers to adoption and incentivise a wider range of RES-H options.	SEAI, DECC	IrBEA, HPA, REI, RGFI, IrDEA	a. Include Eco Design labelled biomass heating solutions and district heating substations. b. Relax max HLI requirement and facilitate cost-optimal home energy retrofits with heat pumps. c. Incentivise off-gas grid homeowners to switch from oil to BioLPG, including with hybrid heat pumps.	Budget 2022	Much of the existing housing stock will remain on fossil fuels for the foreseeable future, and Climate Action targets for heat pumps won't be met.
Cross-sectorial	**RES-Gas4**	A biogas/biomethane support payment/Feed in tariff is required to support biomethane injected onto the gas grid, or shipped to consumers by alternative means. This support is needed to bridge the cost of production of biogas and the current price of fossil gas. This support could be provided by either market or exchequer support.	To support the deployment of RES-Gas production and decarbonisation of heat and transport.	DECC, SEAI	IrBEA, RGFI	a. DECC to introduce a feed-in tariff for certified biomethane injected onto the gas grid, or shipped to consumers by alternative means.	Dec 2021	Hard to decarbonise sectors lagging behind and their economic activity being impacted by lack of 'carbon' competitiveness.

Capacity Building

Sector	Policy Improvement	Description	Aim	Lead	Supporting Role	Next Step	Target Date	Impact of delay on achieving 2030 targets
Cross-sectorial	**DH4** **DH Delivery Company**	Establish a utility, or mandate an existing one, to develop DH networks at scale. The transmission & distribution infrastructure would primarily be in public ownership, with co-ownership & operation models possible where appropriate.	Prioritise large scale roll-out of 'essential public infrastructure' DH networks in areas with high heat demand density.	DECC, DHLGH, DoF, DPER	Local Authorities, CRU, SEAI	a. Propose legislation to establish a DH state company. b. Allocate €50 million per year of OPEX under a Price Control. c. CAPEX allocation (see DH4). d. Reassign 40-50 people with expertise in planning, procurement, financing and others.[32]	a. H2 2021 b. Budget 2022 c. Budget 2022	The target for DH by 2030 is 10%, for every year delay it will decrease this target by ~1%.
Cross-sectorial	**All RES-H8** **Training & education**	Resource provision of training for trades people in RES-H technologies installation and maintenance to ensure quality and consumer protection.	Huge need to train heating system designers and heat pump installers- SEAI estimates 1,600 additional FTE installers are needed.	SEAI, HPA, 3rd level institutes, SOLAS	HPA members, DECC, IrBEA	a. Investment in training facilities to equip and resource for the delivery of RES-heat installation & maintenance courses. b. Mandate QQI level 6 accredited training and manufacturer training for installations.	H2 2021	Immense – targets will be missed if the delivery capacity falls.
Local communities	**DH5** **Community & LA DH support**	Support for local authorities & community groups to develop local DH schemes, with appropriate guidance and support from trusted intermediaries.	Enable local communities in partnership with the national DH company (see DH5) and LAs to develop local DH networks with community benefit/ ownership.	SEAI	DECC, IrDEA, RGFI, IrBEA	a. SEAI to create guidance/training for community DH schemes. b. Establish 'trusted intermediaries' to provide technical support and guidance in DH project development.	H1 2022	Energy transition is no just, with open participation, and lack of community acceptance.
Cross-sectorial	**GeoH3**	Research support to further progress the regional scale mapping of geothermal resources.	To improve spatial knowledge of geothermal resources and project opportunities.	SEAI, SFI	DECC, GAI	a. Annual call for proposals for RD&D in geothermal resource assessment.	H1 2022	Lack of confidence and knowledge in geothermal resources slows investment.

[32] For comparison, GNI currently receives a budget of approximately €60 million per year for OPEX (p5) and €60 million per year for CAPEX (p4) under a Price Control that is regulated by the CRU: https://www.cru.ie/wp-content/uploads/2017/07/CER17128-PC4-CER-Consultation-Paper-October-2017-to-September-2022-Transmission-Revenues-for-GNI.pdf

Summary of industry-led actions

Capacity Building

Sector	Industry-led actions	Description	Aim	Lead	Supporting Role	Next Step	Target Date	Impact of delay on achieving 2030 targets
District Heating	**DH1** **Roll-Out Plan**	Create a strategic roll-out plan for DH in Ireland with 2030 and 2050 targets, including required upskilling, capacity building and customer acceptance, and examining sector integration opportunities.	To reach full DH potential across Ireland, which is 35-55% of the heat demand in buildings.	IrDEA, SEAI, National DH Company	DECC, LAs, EirGrid/ ESBN	Publish 2030/2040/2050 roll-out plan in consultation with sector stakeholders, targeting highest impact areas as a priority.	H2 2021	Without a long-term strategy for DH, the 2030 roll-out may not be optimally designed for a zero carbon energy sector in 2050.
District Heating	**DH2** **DH Centre of Excellence**	Create a partnership between industry and academia to bring best practice and research on DH to Ireland.	To upskill Irish energy sector and stay up to date on and apply latest DH technological developments.	IrDEA	An Irish University/ College, Industry Partners, IDA/SFI	IrDEA to identify relevant partners.	H1 2022	Lack of expertise and innovation impairs rapid development of DH in Ireland according to best practice.
District Heating	**DH3** **Bring international expertise to Ireland**	Connect with EU companies which are well-established in DH and attract to Ireland due to opportunity available.	Encourage scaling-up of Irish DH industry building on capacity of leading EU companies.	IrDEA	Industry Members	IrDEA to promote findings of the heat study and role of DH across U markets.	Ongoing	Irish DH industry too small and inexperienced to upscale DH deployment.
Solid biomass	**BioHEAT1** **Feasibility study & business case models**	Work with industry and government to develop cost models for bioenergy projects in commercial and industrial heat installations, within and outside the ETS, and elaborate supply chain and resource pathways.	Provide confidence to potential users of biofuels and the investor community regarding financial viability, GHG savings, biomass resource quality and availability.	IrBEA, RGFI	DECC DAFM SEAI	Development of model costings models and supply chain and resource information.	H2 2021	Lack of investor and industry confidence on bioenergy costings and GHG and CR benefits constraining fuel switching.
Cross-sectorial	**All-RES-H1** **Training & upskilling**	Roll out industry-led training programme for designers and installers, as well as BER assessors & other building professionals.	Increase the number of skilled professionals with RES-H competence.	REI members	Industry Members	Associations to identify knowledge gaps in their sector and continue rolling out CPD programmes.	Ongoing	Lack of indigenous know-how slows down RES-H deployment and arms quality.
	RES-Gas1	Align Biogas projects with EGD and implementation of farm to fork and industrial waste strategies, i.e. Paris Agreement.	Industry to comply with its regulatory and compliance requirements of Paris Agreement, and alignment with Climate Action Plan, NECP and Ag Climatise.	RGFI, IrBEA	Industry led – Project Clover, Community Power, DPER, DRCD, DAFM & DECC	a. Secure commercial funding. b. Capital grants and support scheme funding to projects to stimulate indigenous AD biomethane industry.	H2 2021	Placing Ireland Inc, manufacturing and processing industries in an anti-competitive position and commercially unsustainable.
	BioHeat2 **Biomass Capacity Statement**	Develop a Biomass Capacity Statement to assure large scale heat users that biomass is available and the infrastructure to supply it.	Instil confidence in large energy users of the long term security of supply of biomass fuels.	IrBEA	SEAI	Produce detailed report on: a. Raw material availability over the next 20-30 years. b. Biomass industry capacity to process and supply quality fuel. c. Industry expertise to install and maintain large biomass plant.	2021	Large industry requiring high grade heat will remain on fossil fuels, or will be forced to adopt costly alternatives.

Innovation

Sector	Industry-led actions	Description	Aim	Lead	Supporting Role	Next Step	Target Date	Impact of delay on achieving 2030 targets
Solid biomass	**BioHEAT3** **Research & Development in bioenergy carbon capture & advanced fuels**	Extend the benefits of sustainably sourced bioenergy through research and development focussed on bioenergy carbon capture, storage, and use (BECCS/U), second generation biofuels, and biorefining/bioenergy synergies.	Enable advanced bioenergy technologies to extend their contribution to reductions in near term GHG emissions and the development of the circular bioeconomy.	IrBEA, RGFI	DECC SEAI DAFM SFI	Input to research and development policy and advocate for pilot projects related to advanced biofuel technology testing and deployment.	Ongoing	Failure to invest in RD and D in these areas will disadvantage Ireland's efforts to make the fundamental changes needed to decarbonise the economy and society.
Solid biomass	**HP1** **Research & Development**	Improve energy monitoring and usage data available for case studies, innovation in system design and controls. To explore complementarity of heat pumps with PV, battery storage, and electric vehicles – looking also to medium term future move to net zero buildings.	To increase the sector's ability to improve heat pump systems performance and develop ancillary services.	HPA, HPA members	HPA, SEAI, 3rd Level institutes	An R&D strategy paper needs to be developed. Consider partnership/ links with LIT, TEA etc.	H2 2021	Lack of innovation and poor practice lead to underperformance of HP and poor confidence among potential HP buyers.
Renewable Gas	**RES-Gas2**	Support ongoing investment in research and development focussed on renewable gas, including BioLPG pathways to support the decarbonisation of the off-grid energy market.	Enable advanced renewable gas solutions to contribute to GHG emissions reductions, cleaner air, water quality and the development of the circular bioeconomy.	RGFI, IrBEA	DECC, DAFM, SFI. NUIG	a. Input to renewable gas research and development policy. b. Identify research and development of national & EU collaborators to work on advanced biofuel technology options.	Ongoing	Long term ability to deliver supply pathways and contribute to enduring solutions to the decarbonisation of the off-grid heat sector.
	All RES-H2 **Decarbonisation of low energy efficiency houses**	Explore options for using biomass as a solution for homes where retrofit is not an option due to excessive capital cost of retrofit, or architectural/ heritage reasons.	To identify technology options to decarbonise homes that otherwise would have no option to move from fossil fuels. Identify support measures to encourage adoption.	IrBEA, RGFI	SEAI	Develop proposals and financial models of support measures that will incentivise home owners to replace fossil fuel systems with cost effective renewable heating systems. For consideration by SEAI / DECC for the introduction of support measures.	H4 2021	Many homes will remain on fossil fuels for the coming decade and beyond.

Quality Assurance

Sector	Industry-led actions	Description	Aim	Lead	Supporting Role	Next Step	Target Date	Impact of delay on achieving 2030 targets
District Heating	**DH4** **Standardised Designs**	Create a catalogue of designs for typical Irish buildings e.g. housing estates, and technical guidance for M&E designers of secondary side DH installations.	Upskill and bridge knowledge gap, increase efficiency in secondary side systems.	IrDEA	CIBSE Engineers Ireland	a. Secure funding. b. Develop the code and consult with stakeholders. c. Publish the code.	a. H1 2021 b. H2 2021 c. H1 2021	DH system engineering of sub-standard or not adapted to Irish conditions.
District Heating	**DH5** **Develop voluntary Consumer Protection**	In the absence of market regulation, establish a voluntary customer service standard for DH operators (e.g. Heat Trust UK) as an independent, non-profit consumer champion that holds the industry to account for the benefit of everyone involved.	To protect and give confidence to the consumer and add transparency and high standards to DH operations in Ireland.	IrDEA	DECC, CRU	a. Secure funding & buy-in. b. Establish voluntary body. c. Operate the service.	a. H2 2022 b. H1 2023 c. H2 2023	Poor customer protection results in lack of confidence in DH and adoption.
Heat Pumps	**HP2** **Quality Label**	Quality assurance schemes to provide heat pump buyers with sufficient warranties and supports to allay any performance concerns.	Protect consumers and increase confidence in HP technology.	HPA	SEAI	a. Research existing quality standard models e.g. EU Heat Pump Keymark. b. Establish quality standard scheme in Ireland.	a. H2 2021 b. H1 2022	Lack of confidence in HP leads to low levels of adoption.
Solid biomass	**BioHEAT4** **Quality Assurance for Wood Fuels & Training for installers and designers**	Further develop and grow industry competence through the Wood Fuel Quality Assurance (WFQA) scheme, Biomass Designers Register and Biomass Installers Register.	Promote high standards across all levels of the industry and reinforce consumer confidence.	IrBEA	REI	a. IrBEA to continue to grow, promote and develop the WFQA Biomass Designers Register and Biomass Installers Register. b. Roll out an information campaign on use of dry quality wood fuels at domestic level. c. Training for installers and designers.	a. Ongoing b. Dec 2021	Reputational damage to the industry and low uptake of biomass in the marketplace.
Renewable Gas	**RES-Gas3** **(Voluntary) Biomethane Certification Scheme**	Green Gas Certification scheme (GGCS) for Ireland is in place and operational with biomethane being injected into the gas grid, certificates issued to the biomethane producer and claims made by the shipper/end consumer.	This will certify Renewable Gas for use by industrial heat users.	GNI, RGFI	DPER, DECC, REI, DAFM, DBEI IrBEA, CRU	The GGCS for Ireland was designed by DENA & DBFZ in compliance with the REDII sustainability criteria, with verification/auditing by either ISCC and RedCert as the recognised entities by the EU Commission.	Operational since Feb 2021	Consumer confidence and certification that complies with REDII sustainability criteria. Verification required by accredited entities recognised by EU and Global authorities.

Awareness-Raising

Sector	Industry-led actions	Description	Aim	Lead	Supporting Role	Next Step	Target Date	Impact of delay on achieving 2030 targets
Cross-sectorial	**All RES-H3** **Large Heat Users Awareness Campaign**	Engage in an awareness campaign with high temperature heat users on the options to transition to renewable heat sources such as biomass, biogas/ biomethane, bioLPG and electrification, along with how they can provide surplus heat to district heating networks.	Highlight resources available. Improve the knowledge of the industry to the options available, sustainability of biogas and biomass, highlight the benefits for transition.	REI, RGFI, IrBEA, IrDEA	SEAI, IDA, IBEC	a. Develop a list of large heat users. b. Prepare a targeted campaign. c. Roll-out multi-annual awareness-raising campaign & CPD.	H2 2021	Slow decarbonisation of industrial sector, impacting on international competitiveness of Irish goods and economy.
Heat Pumps	**HP5** **Awareness-raising campaign**	A national communications strategy for heat pumps needs to developed, led by SEAI, DECC, partnership with industry & electricity suppliers.	To increase awareness of heat pump solutions to the Irish public and to stimulate interest and appetite to adopt.	HPA	SEAI, DECC, Energy Suppliers	a. Develop a coordinated communication plan. b. Resource a multi-stakeholder plan. c. Roll out communication campaign on a sustained basis.	H2 2021	If the mass market is not convinced of the necessity to use heat pumps, it will be impossible to achieve the 400,000 HP retrofits.
Renewable Gas	**RES-Gas 4**	Develop consumer-led case studies and industry alliances that demonstrate and promote the tangible benefits of renewable gas solutions including biogas/biomethane and bioLPG to the off-grid domestic and non-domestic heat sector.	Enable advanced renewable gas solutions/biogas /biomethane/ bioLPG to contribute to GHG emissions reductions, cleaner air, water quality and the development of the circular bioeconomy.	RGFI, IrBEA	DECC, DAFM, DBEI, DPER, SEAI	Work with SEAI to identify how consumer case studies can contribute to general education and awareness of renewable heat solution deployment. Form key industry alliances that can support the promotion of the renewable gas solutions for the off-grid domestic and non-domestic heat sector.	Ongoing	Lack of education and awareness of the lessons learned and success stories on decarbonising off-grid heat. Lack of Informed consumer choice in selecting renewable heat technology.

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